SCIENCE AND CULTURE

AUGUST 1938
VOL. IV NO. 2

A Monthly Journal of Natural and Cultural Sciences

(1) 2 Book

IMPORTANT ARTICLES IN THIS ISSUE

Social Implications of Science

Electrical Charge Distribution in Thunderclouds

The Origin of the Planets

Royal Society of London

Review of the Rockefeller Foundation

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SCIENCE AND CULTURE

Published under the Auspices of

THE INDIAN SCIENCE NEWS ASSOCIATION

AUGUST 1938

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EDITOR, SCIENCE AND CULTURE

All Business communications are to be addressed to
The Assistant Secretary,
Indian Science News Association

EDITORIAL AND BUSINESS OFFICE
UNIVERSITY COLLEGE OF SCIENCE
92, Upper Circular Road,
CALCUTTA

SCIENCE AND CULTURE

AUGUST 1938

VOL. IV NO. 2.

A Monthly Journal of Natural and Cultural Sciences

The Social Implications of Science

THINGS that happen before our eyes from day to day tend to be accepted by the common mind as a matter of course as things for granted although they, in fact, may result in revolutionary changes in our modes of life. The truly phenomenal advances in science and technology during the last two hundred years have affected almost every aspect of our individual and social life. None of us to day can have his food or take a step or write a line without using the inventions of science in one form or other. Nevertheless, even otherwise cultured men are not few who are ignorant of the elements of science and are not sufficiently conscious of the role that science is playing almost literally every minute in their life. This, by itself, would be a misfortune. But it is rendered all the more regrettable when it is considered that science, apart from working far-reaching changes in our social life, has now placed in the hands of man powerful engines of destruction which, if used by unscrupulous men or for unscrupulous purposes, can produce untold harm, and even wipe out whole communities.

The reality of the danger has never been so great to Western people generally as now. The rise of totalitarian States and the ruthless way in which the latest scientific discoveries are being used for aggressive purposes openly and unabashedly have struck terror in the minds of the people in the Western democracies,, who were relatively calm up till now. Mass dismissals of eminent scientific men in Central Europe for reasons of political conviction or religious faith have unnerved the Western democrats and scientists who were hitherto unmoved by the suppression of scientific and scholastic careers in colonial countries on political grounds by the governments of these democrats themselves. They were still unaware that suppression of freedom in any part of the globe is potentially dangerous to freedom even in their own countries, even as slums in a city are dangerous to the richer people themselves, who are directly or indirectly responsible for the slums. To-day the Western intelligentsia have become alive to the problem. It is now generally admitted that scientists themselves are to a certain extent to blame for this state of affairs, not because, as is sometimes erroneously argued, scientists are responsible for the discoveries and inventions, but because scientists, being naturally absorbed in their own work, have not paid due regard to the social implications of their work. They, as a class, have not tried to inform and train the public mind with regard both to the good and bad potentialities of scientific kiowledge and to instruct people to adjust social and international relations to the progress of science and technology. Efforts are now being made in America and in England and also internationally to make scientists conscious of the duty they owe to society in this regard.

The International Council of Scientific Unions set up last year a Committee on Science and its Social Relations, which was instructed to prepare a report on the effects of science on human life and social relationships and present its report in 1940. For this work the Committee is expected to receive collabo-

ration from national correspondents and scientific societies in various countries. The Council of the American Association for the Advancement of Science has also formally pointed out in a resolution the changes in the physical and mental environment of man and the complexities of social, economic and political relations that are being brought about by science and technology. Both the British Association for the Advancement of Science and the American Association are seriously considering these social problems created by science. Views of representative scientific men in Great Britain on this question were sought recently by *Nature* and there seems to be a general concensus of opinion that a society for the study of the social relations of science is needed. A concrete scheme for the organization of such a society and for its lines of work is naturally more difficult of formulation, but it constitutes at least a re-assuring symptom of the growing awareness of scientific minds to the urgency of the question. We consider it desirable that the Indian Science Congress Association should discuss this question in a plenary session in the forthcoming Lahore Congress, and, if necessary, organize a Committee for the study of this question. The social implications of science are even more ignored in this country than elsewhere, as the mass of the people is ignorant and illiterate. But India is as much within the orbit of the action of deadly scientific weapons as any other country. India, as a nation, is really at the threshold of her scientific career, and if her scientific men organize their thoughts betimes with regard to social, economic and political questions, it may be possible to arrest drift and guide her destinies in the direction of social progress and peace. India, like many other countries, abounds in quacks—medical, political and spiritual and the help of sincere scientists trained to study problem with objectivity and without prejudice may help to steer her course evenly in a sea of passion and unscientific thought.

It is, however, clear from the above that those scientists who are willing to study social problems must bring a scientific mind to bear upon this study. It is not infrequent that scientists, who pursue a scientific way of thought in the laboratory, fail to retain the same attitude in other affairs, and in the study of social questions considerations inspired by prejudice and selfishness have a knack of coming in unobtrusively unless kept at bay by a vigilant mind. It must be borne in mind that the present dislocation in the entire world is the result of maladjustment between scientific development on the one hand and social and international relationships on the other. Scientific methods of communication have largely wiped off the significance of geographical and even of linguistic boundaries. Mankind inevitably, by the impact of science, is moulding itself into one community economically, but the mental separateness persists, racial and national rivalries exist and have even aggravated, religious intolerance has in some countries increased. The light of science must dispel this darkness and show the way for mankind. If Indian scientists can form themselves into such a body with such a task, they will deserve well not only of India but of the entire world.

Electrical Charge Distribution in Thunderclouds

A. K. Dutta

Bose Research Institute, Calcutta.

The phenomenon of lightning has been, for a long time, known to be a case of discharge of electricity through the atmospheric medium. The nature of the distribution of electric charge in the clouds and its surroundings, the cause of such an accumulation of charge to produce the lightning discharge and the nature of the lightning process itself are even now under various experimental investigations. Although success in some of the items may now be rightly claimed, it cannot be said that the whole phenomenon has been thoroughly explained and properly visualized as yet.

Normal Electrical Condition of the Earth and the Atmosphere

Before proceeding to study the problem of thunderclouds and lightning, one must be fairly acquainted with the electrical condition of the earth and the surrounding atmosphere in fair weather. It has been observed that a level field, freely exposed to the sky, is negatively charged. This means that the potential V in the lowest layers of the atmosphere increases with the height, the rate of increase dV/dH being given by $F = 4\pi\sigma$ where σ is the amount of charge per sq. cm. of the ground. The average magnitude of the positive potential gradient in fine weather is of the order of 100 volts per meter, corresponding to a negative charge on the ground of 3 e.s.u. $= 10^{-9}$ coulomb per sq. meter.

The potential gradient soon begins to diminish, and before a height of 10 km. is reached the potential becomes almost independent of the height. Thus the potential, relative to the earth, of the whole upper atmosphere above regions of fine weather is less than one million volts. The normal vertical field of the atmosphere tends to drive positively-charged bodies downwards and thus gives rise to an air-earth current. The average air-earth current in normal conditions is about 2×10^{-16} ampere per sq. cm., that is, about 1,000 amperes for an area equal to the whole surface of the earth. The positive charge thus carried from the atmosphere to the ground in one minute is of the order of 1/10th the surface charge on the ground. It has, therefore, to be borne in mind that unless some other process has been working in a reverse sense, the earth would lose its whole negative charge in about ten minutes. The nature of this compensating process has long exercised the minds of physicists. One theory is that the lightning discharge brings a surplus of negative charge to the earth. In view of the fact that we have about 1,000 active thunderclouds over the earth at any instant, the continuance of the negative charge on the earth would be easily explained, if it could be shown that the discharge between the cloud and the ground gave negative charge to the ground and the thunderclouds induced an earth-air current of considerable amount.

Polarity of Thunderclouds

Whatever may be the process (the exact process has not yet been well established) which renders the thunderclouds electrically charged, it must be based on the fundamental idea that both positive and negative charges are created in the active sphere of a thundercloud and the two types of charges separate in different directions as in the charging of a condenser by the familiar *Wimshurst machine*. A thundercloud must, therefore, be electrically bipolar. If the charge in the lower portion of the thundercloud is *negative* the thundercloud is said to be of *positive polarity* and *vice versa*.

The general method of finding out the polarity of a thundercloud is to find out the electrical field on the surface of the earth in the presence of a thundercloud, whether near or distant, or the change in the

field during a flash. The general method of finding out the field or the change of field on earth was devised by C. T. R. Wilson. In principle the method consists in determining the charge induced on an earth-connected conductor by means of a capillary electrometer. The earth-connected conductor could be of the form of a test plate lying on the ground and properly shielded or a copper sphere placed at a few meters above the ground and connected through the electrometer to the ground. If the capacity of the whole conducting system is known, the potential or the field is easily determined, from the reading of the electrometer.

Appleton and his co-workers, while studying the nature of the atmospherics, have used the cathode-ray oscillograph for the determination of the sign and magnitude of net changes of the earth's electric field due to a lightning. This, however, does not enable one to measure the steady field on the surface of the earth. The oscillograph yields, moreover, certain complex details, all of which have not yet been explained. Simpson tried to decide the question of polarity of thunderclouds on general grounds. He attempted to form a complete picture of the origin of charge distribution in a thundercloud, which automatically links up the question of polarity.

The origin of electricity in a thunderstorm was considered by Simpson to be due to the breaking up of water drops by an upward current of air. It was considered by him that, when a water drop is so broken up, the water particles acquire a positive charge and the air gets a negative charge. In the case of thunderclouds, generally, the air enters the cloud at its lower base and proceeds upwards in a slanting direction. The vertical component of the upward current of air increases as the air passes into the storm area and reaches a maximum at the lower half of the cloud. Outside the region again, the vertical velocity is less. Water drops cannot enter this region of maximum air current and are, therefore, checked, broken up and thrown upwards only to accumulate again and repeat the same process.

Some of these water drops, however, will slip downwards by the side of the region of maximum velocity. Regarding the electrical nature of the region it was considered that the process of breaking water-drops above the region of maximum velocity, *P*, gives a positive charge to the water drops in the area. The negative charge is carried away by the air and is distributed in the remaining cloud. The distribution of charges will, therefore, be as shown in the adjoined figure 1. We see from this figure that the heavy rain drops near the centre of the storm are positively charged and the rain

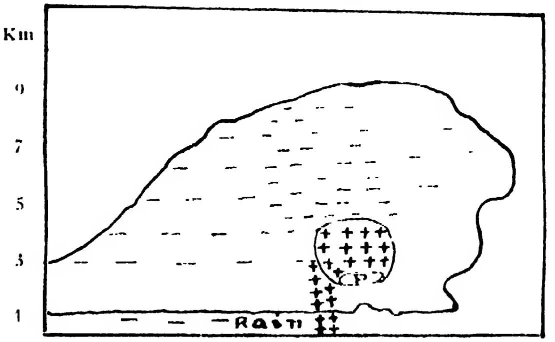

Fig. 1.

drops in the region away from the centre are negatively charged. The separation of the charges convert the thundercloud into something like a huge condenser. Simpson says that the charge of the rain drops has sometimes been found to be positive and sometimes negative. Sometimes the rain drops have a mixture of positive and negative charges. This is, evidently, in accordance with his theory.

On the assumption that the air is unable to withstand more than a certain definite electrical intensity and that the mobility of the negative electrons is much larger than that of the positive ions, Simpson argued that a positive discharge is expected to create an intense field at the end of a *progressing* channel of positive charge, with a tendency to produce branches. A negative discharge, on the other hand, cannot produce a channel but forms a diffuse ionized region. Experimenting in the laboratory, he found a characteristic branched discharge from the positive terminal and a diffuse glow from the negative terminal. Further experiments with a positively charged plate to represent the earth and a negatively charged sphere to represent the cloud gave, at comparatively shorter distance, a thick discharge from the plate to the sphere. The general nature of lightning

ELECTRICAL CHARGE DISTRIBUTION IN THUNDERCLOUDS

photographs show many branched discharges and many unbranched thick ones, the majority being branched discharges downwards. Thus he came to the conclusion that the lower end of the active thundercloud is positively charged and the thunderclouds are, therefore, of *negative polarity*. This is evidently what the picture depicted by Simpson leads us to believe.

However elegant and complete the theory propounded by Simpson may appear, it has not stood the test of subsequent and more elaborate experiments of Schonland and other workers, who have definitely established that the thunderclouds are generally of *positive polarity*.

Experimental Tests on the Polarity of the Thunderclouds

The question of polarity of thunderclouds was first attempted by Wilson by studying the change of electric field on the earth due to a lightning.

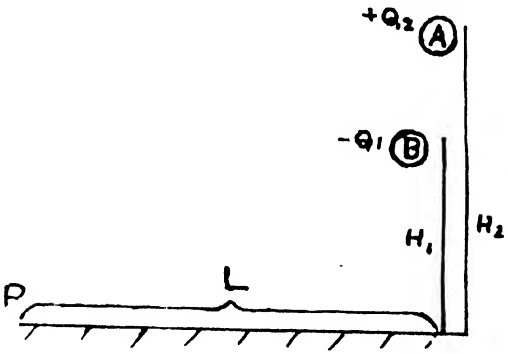

FIG. II.

From his observations he came to the conclusion that a great majority of the thunderclouds were of positive polarity, that is, the lower portion of the cloud was negatively charged. Experiments by Appleton, Watt and Herd with the oscillograph also supported the idea of positive polarity of the thunderclouds. Schonland and his co-workers are responsible for the elaborate and definite proof on the question of polarity of the thunderclouds. The recording apparatus used by Schonland was like that of Wilson, —a copper ball or a test plate worked along with a capillary electrometer. As a preliminary to the working theory, it is considered that thunderclouds are essentially bipolar. In a bipolar cloud of the ideal condition shown in the figure II, the field at the point of observation P is given by,

$$F = \frac{2Q_2 H_2}{(H_2^2 + L^2)^{3/2}} - \frac{2Q_1 H_1}{(H_1^2 + L^2)^{3/2}}$$

where Q_1 and Q_2 are the negative and positive charges and H_1, H_2 their heights from the ground. L is the distance from the base of the cloud to the point of observation. For distances L less than a certain critical value, the second term predominates and for large distances the effect of the first term predominates. *Thus with increasing distance L between the cloud and the station the field will change its sign.* In general, however, this may be difficult to observe due to the presence of several thunderclouds at varying distances.

Electrical nature of the cloud may also be determined by studying the change of field associated with a lightning discharge. We may consider three types of lightning discharges, that between the positive or the negative charge and the earth, or between the two poles of the cloud. Writing C for the earth and A and B for the positive and the negative poles of the cloud, the sudden change of field resulting from the various discharges may be given by the following expressions.

Discharge AC [positively charged part of the cloud to the earth],

$$\triangle F = -\frac{2Q_2 H_2}{(H_2^2 + L^2)^{3/2}}$$

,, BC [negatively charged part of the cloud to the earth],

$$\triangle F = +\frac{2Q_1 H_1}{(H_1^2 + L^2)^{3/2}}$$

,, AB [Lower Cloud negative], $\triangle F$

$$= -2Q_2\left[\frac{H_2}{(H_2^2 + L^2)^{3/2}} - \frac{H_1}{(H_1^2 + L^2)^{3/2}}\right],\ Q_1 > Q_2$$

$$= -2Q_1\left[\frac{H_2}{(H_1^2 + L^2)^{3/2}} - \frac{H_1}{(H_2^2 + L^2)^{3/2}}\right],\ Q_1 < Q_2$$

ELECTRICAL CHARGE DISTRIBUTION IN THUNDERCLOUDS

It is evident as in the case of the steady field, previously discussed that the pole to pole discharge gives a reversal in the change of field observed as the distance changes. This can be tabulated in the form :—

Discharge.	Sign of sudden field change. Distant cloud of positive polarity.	Near cloud of positive polarity.
AB	Negative	Positive
BC	Positive	Positive
AC	Negative	Negative

It has been observed that the great majority of lightning discharges pass between the upper and the lower parts of the cloud. Discharges from the lower pole to the earth are less frequent, while the discharges from the top pole to the earth are rare. With a cloud of positive polarity, generally, all *distant* discharges within the cloud (*AB*) should produce negative change of field, while lightning discharge in a near cloud of positive polarity (*AB*) should produce positive change of field.

If the observed positive field changes due to distant discharges are all associated with discharges to the ground, *C*, then, it may be said that no positive field changes are associated with discharges between the clouds and the cloud is of positive polarity.

The steady fields due to near and distant storms are respectively positive and negative for negative polarity and negative and positive for positive polarity. In view of the superimposing fields this is, however, not an absolute criterion.

The records of observation definitely favour a positive polarity of the cloud.

(1) Out of 523 *distant* discharges *within* the cloud 517 were associated with negative field changes and 6 with positive. (Type *AB*).

(2) Out of 54 positive field changes of distant clouds 48 were associated with discharges to the ground. (Type *BC*).

(3) Positive steady fields were associated with distant storms and negative steady fields with near storms.

These observations of Schonland have been later verified by Halliday and others. Having thus established that the thunderclouds are of positive polarity, that is, the base of the cloud is negatively charged, it can now be explained why in spite of the steady air-earth current of normal conditions (positive charge moving to the ground) the earth maintains the constant negative charge on its surface.

Explanation of the Negative Charge on the Surface of the Earth

Wilson was the first to suggest that the exchange of electricity between the thunderclouds and the ground may be an important factor in the maintenance of the earth's negative charge, the replenishment of which, in view of the fine weather air-earth current, is an outstanding problem of atmospheric electricity. This exchange can take place in three ways, *viz.*, by the momentary currents due to lightning discharges between the cloud and the ground, by the total charge carried by the downpouring rain, and by the continuous current carried by the ions in the powerful electric field between the cloud and the ground. The last effect is expected as a result of point-discharges from trees and bushes below the cloud.

Occasions of strong posit ve fields below active nderclouds are negligible. There is a preponderance of strong negative fields, which causes the point discharge current to be mainly upwardly directed. The earth must, therefore, gain a negative charge from this effect. It has been shown that the lightning discharge takes place between the negative cloud and the earth. The earth, thus, gets a negative charge from this effect also. The rain, on the other hand, may be expected to convey a positive charge to the earth, as the falling drops, whatever their initial condition, will intercept enough of the positive ions before reaching the ground.

In order to estimate the point discharge currents from trees and bushes below the cloud, Schonland selected some natural source of point discharge, which is a typical tree in the region in which the experiment was carried out. This was cut down at the base and mounted upon sulphur-ebonite insulators. The tree was joined to a current-measuring instrument, the connecting wires being properly shielded. A unipivot galvanometer was used as the current measuring instrument, which was earthed properly.

It could read to tenths of a microampere. The current observed rapidly increased with the increase of field, as will be seen from the following table:

Steady field on the surface of the earth Volts/meter.	Current in microampere
3,500	·07
-5,500	·20
- 11,000	1·00
- 16,000	4·00

Positive fields being due to distant storms are never very powerful and, therefore, the current is always negligible. Measuring the average current due to the various storms at different distances and finding out of the chief sources of point discharges and their relative abundance, Schonland made a rough estimate of the total point discharge current between an active thundercloud and the ground. He found this current to be 2·1 amperes. The effect of momentary currents carried by lightning discharges is ·1 ampere in an upward direction, charged rain carries 0·02 ampere downwards.* In view of the abundance of active thunderstorms at any time, it is probable that the air-earth current is well balanced by the gain of negative charge by the earth due to thunderstorms.

Determination of the Electric Charge Distribution in the Thundercloud

In a very recent experiment, Simpson has measured the potential fields in the thundercloud itself, by means of sounding balloons and has found out the general nature of the charge distribution in the clouds. These results are in general agreement with the idea of the positive polarity of the majority of the clouds, thus tallying with Schonland's results and with those of others. Simpson has also modified his theory to suit the general nature of the charge distribution in the clouds as found new, and has carried out further laboratory experiments to justify his theory.

* Recently Dr S. K. Banerjee has reported that he has found the total charge carried by raindrops to be negative and of sufficient amount.

The main principle of his work was to attach a point-discharge system with a sounding balloon. The record of the discharge was imprinted on a chemical paper which was made to rotate by means of a clockwork. Arrangements for recording the humidity and the pressure were also sent along with the balloon. All the scientific instruments were released by means of a fuse at any desired height and these came down by means of a parachute. The soundings were generally made in thunderstorms or in showers.

The records show that at least two-thirds of the soundings give a negative potential in the lower regions up to 3 km., which is usually above the base of the thunderclouds. From the top of the negative gradient up to eight or nine kilometers positive gradients predominate. The evidences at greater heights point to negative potential again. There are, however, also cases on record, which start with a positive potential, change to a negative potential and again pass over to a positive potential. These records indicate that although generally the charge in the lower part of the cloud is negative and the upper part positive, there are some cases where the balloon meets a positive charge to start with and then comes to a negatively charged region followed again by positive charge. It has been further calculated that the centre of gravity of the main negative charge lies in the region of temperature above 0°C, while the centre of gravity of the positive charge lies in the freezing temperature region of -10°C. The specimen records are well illustrated by Z_1 and Z_2 in the following figure III,

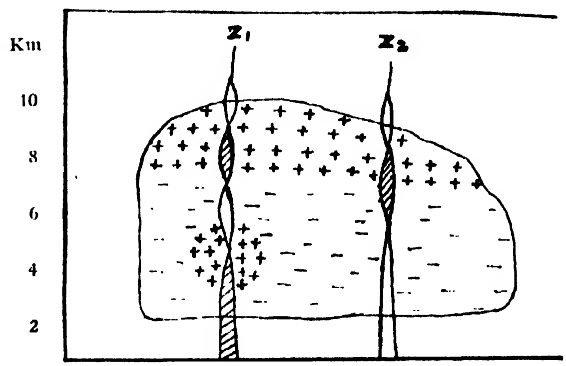

Fig. III.

where the shaded portion denotes the positive gradient and the unshaded ones the negative

gradient. The majority of the records are of the type Z_2. These records are explainable on the basis of the cloud charge distribution shown in the figure. The modifications necessary from the earlier theory of Simpson arise from the fact that there is a large positive charge at the top of the *cloud and the negative charge in the general cloud is much denser. This means that the general nature* of a thundercloud charge is positive above and negative below, while only under specially selected regions a concentration of positive charge is found embedded in the lower region. The previous breaking drop theory of Simpson had accounted for the concentration of positive charge in a limited lower region. As regards the upper positive charge, it is now suggested that the mutual impact of ice crystals results in the ice becoming negatively charged and the air positively charged. This is based on observations made in the Antartic by Simpson. In view of the fact that the upper region of positive charge is below the freezing point temperature, occurrence of ice crystals in the region is according to expectation. The general settling of negatively charged ice would then result in a separation of electricity with the positive charge above the negative. Simpson, however, points out that this explanation has not yet been confirmed by satisfactory laboratory experiments.

Conclusion

In conclusion, it may be suggested that there are two types of thunderclouds generally. One, that is associated with considerable amount of rain and the other, which is not associated with much of rain. In the whole series of experiments by Schonland in Scuth Africa, during the three months in which a considerable number of thunderstorms were studied, only 2·02 inches of rain fell. Scarcity *of rain suggests smaller water drops and, therefore,* one should not expect the breaking of drops to occur in such cases. The absence of this mechanism would indicate that there is no accumulated positive charge in the lower region of the thunderclouds. In the case of thunderclouds associated with much rain one expects the breaking of water drops process to be in force and hence an accumulation of positive charge somewhere in the lower strata. By studying the potential gradient in these two different types of clouds, one could try to verify the theory of breaking drops given by Simpson. As regards the suggestion that the ice crystals settle down gradually with negative charge, giving the positive charge to the air above, it is possible to try various laboratory experiments to test it and before the theory can be definitely accepted one must find out the verification. In view of the large number of thunderstorms occurring in India, we are in an advantageous position to make some contribution to this interesting problem before it is finally settled.

Pluto May Be Larger Than Supposed

Pluto, the ninth planet of the sun's family, may be larger in size than now estimated. Sir James Jeans has suggested that this distant planet is so remote and cold that it is covered w ı a layer of quid air.

Acting like a mirror, this supercold liquid air would give a minute image of the sun. This is what astronomers would see when they observe the planet. The sunlight from the outer portions of the disk would not reach the earth. The apparent brightness of Pluto would give a too conservative idea of its size. A size for Pluto larger than that of the earth, which might be possible according to this theory, would support the idea that Pluto exercises a noticeable effect on both Neptune and Uranus. This was the basis of the late Prof. W. H. Pickering's prediction of a ı planet made before Pluto was discovered.

—*Science Digest.*

The Origin of the Planets

James H. Jeans

As soon as the reasoning of Copernicus and the observations of Galileo had elucidated the nature and motions of the planets, hypotheses and speculations as to their origin were put forward in profusion. Theories were propounded by Descartes in 1644, by Swedenborg in 1734, by Thomas Wright in 1750 and by Kant, the philosopher, in 1755. Finally Laplace in 1796 put forward his famous "nebular hypothesis," which was destined to hold the field almost unchallenged for nearly a century.

Laplace's Theory of Nebular Origin

Laplace first noted that all the planets revolve around the sun's equator in the same direction, namely that in which the sun is itself rotating. This led him to conjecture that the matter of the planets had originally constituted, or formed part of, a vast atmosphere which enveloped the rotating sun and rotated with it, so that the sun at this stage had formed a vast gaseous nebula with the present sun forming a stellar centre. Gradually this nebula cooled. As it cooled it shrank, and continually spun faster and faster in accordance with the well-known principle of the conservation of angular momentum. Finally a speed was reached at which the nebula could no longer hold together as a single body; just as a fly wheel breaks up if it is spun too fast, so the great nebula broke up, and out of the debris the planets were formed.

Laplace studied the method of break-up in some detail. The shrinking sun, he found, would continually leave matter behind in its equatorial plane. This would continue revolving round the sun at the speed at which it had rotated while it still formed part of the sun's equator, and so at a slower rate than that at which the sun was then rotating. He imagined that this slowly-rotating matter would condense in due course into a planet, after which the process would begin again, until a second planet was born, and so on.

Laplace was too good a mathematician to go wrong in his mathematical theory, but the Kinetic theory of gases was still unknown, and he went wrong in his physics. We know now that a stream of gas slowly liberated from the equator of a rotating sun would not condense into planets; instead, its atoms or molecules would scatter into space, precisely as the molecules do when we turn the gas-tap on in the laboratory, and for the same reason. It is true that structures are known in the heavens —the great spiral nebulae in which the process imagined by Laplace is very probably in progress, but these are on an entirely different scale. Each of these nebulae contains about 100,000,000,000 times as much matter as the sun, and the difference of scale introduces essentially new factors into the problem. Condensation can, and must, occur when the matter is so abundant that its gravitational attraction outweighs the tendency to molecular scattering; it cannot occur on the relatively puny scale contemplated by Laplace.

Laplace pointed to the rings of Saturn as evidence that the process he had in mind could really occur, and a study of these rings takes us into the heart of the problem. Laplace thought that these rings were a satellite in its pre-natal stage; we now think, with reasonable certainty, that they are a satellite after its death. 1852 the French mathematician Roche made a study of the question which most astronomers of to-day find conclusive.

Roche's Theory of Tidal Origin

Let us begin by considering the ordinary everyday tides which the moon raises on our earth. These consist of tides in the ocean which are of moderate height, because water is easily pulled about, and of smaller "earth-tides" in the solid body of the earth-smaller because the earth is denser and more rigid than water. The earth must, of course, produce similar tides in the solid body of the moon;

these are larger than the foregoing, because the earth, owing to its greater mass, exerts a greater gravitational pull than the moon. If the moon were to come closer in to the earth, the earth's gravitational pull on the moon would increase, and these tides would become still greater. Yet Roche found that, in every such case, there is a limit to the height of the tides which will be raised on the smaller body; if this comes too near to the larger body it does not have mere tides raised on its surface, but is pulled in pieces. So far as we can foresee, the moon is destined in remote future ages to come closer and ever closer in to the earth. As it does so, the earth's tide-raising pull on the moon will for ever increase, until finally the moon will no longer be able to resist the strain; it will no longer hold together as a single body, but will break into fragments. We shall no longer have a single moon, but a swarm of minute satellites, like the rings of Saturn, revolving round the earth.

What our satellite will do in the future, we believe that a satellite of Saturn has done in the past. The orbit of this satellite must, we have continually contracted until the strain Saturn's tide-raising gravitational field became too great for it, and it broke into the fragments we now see.

The sky exhibits what appear to be other instances of the same phenomenon. There are comets which have broken into several pieces between successive appearances; some have actually been observed in the act of breaking. Again, according to Bode's law, we ought to find a planet between the orbits of Mars and Jupiter; instead of this we find a whole swarm of minute planets --the asteroids --which most astronomers think were probably formed by the break up of a single planet in the way just described.

According to the tidal theory of the origin of the solar system at any rate in the form in which I propounded it in 1916 --the planets were formed by a somewhat similar break-up, although with one essential and important difference in the conditions. The imagined satellite of Saturn was, we think, broken up by the gravitational attraction of a larger mass round which it described a circular or elliptical orbit. The tidal theory supposes that the sun was broken up by the gravitational attraction of a second star, but round this it would of course describe a hyperbolic orbit. Now a hyperbolic orbit involves only a transitory visit to the region of danger in which break-up occurs, whereas an elliptic or circular orbit involves repeated visits to this region, or even a permanent stay inside it. Mathematical analysis shews that if the sun made a transitory visit into the region of danger of another star, the gaseous tides on its surface would rise continually higher, until finally a long filament of gas would shoot out towards the second star. When the two bodies receded from one another, this filament would be left suspended in space, with a motion of revolution round the sun which would prevent its falling back into the sun. It can be shewn that the filament of gas would condense into globules of gas which would be of the general order of size of planets. The theory suggests that these are in fact the actual planets. They would begin by describing orbits about the sun and if these orbits brought them near enough to the sun, they might themselves be broken up and give birth to systems of satellites.

Such, in its simplest form, is the tidal theory and it obviously explains many of the observed features of the solar system. We see at once why the planetary motions have reference to two planes the plane of the sun's rotation, and the plane in which the outer planets revolve. Clearly the former must have been the plane of rotation of the original sun, while the latter would be the plane in which the second star passed by the sun. We see too why the largest planets, Jupiter and Saturn, are found in the middle of the sequence of planets, while the size tails off at either end of the sequence. For the matter out of which these central planets were formed would have been emitted when the two stars were at their closest approach, the stage in which matter would be emitted most profusely, and so might, we may conjecture, form the largest planets. Further, these central planets, being the largest, would cool most slowly, from which it can be deduced that they ought to be surrounded by numbers of small satellites, while the smaller planets should be surrounded by a few relatively large satellites. Actually we find a regular sequence in the numbers of planetary satellites—0,0,1,2?,9,9,4,1,?. The tidal theory at least makes this regularity intelligible, while no other theory with which I am acquainted attempts to explain it.

THE ORIGIN OF THE PLANETS

Difficulties of the Tidal Theory

Dr Jeffreys and others have recently drawn attention to a difficulty which affects this theory in common with all other that suppose that the planets originally formed part of the sun. The sun rotates once in about twenty six days, Jupiter once in ten hours. The matter which now forms Jupiter, and rotates once every ten hours must at some past time, so these theories suppose, have rotated once only in twenty six days. What has produced the increased rate of rotation? It cannot have been mere shrinkage, since calculation shews that if this were the only cause in operation, the original Jupiter must have been larger than the sun. Clearly then some external force must have got a rotational grip on the matter and set it spinning faster. The difficulty is to find any external force of sufficient potency.

As the tidal forces from the passing star could at best set up only a very slight amount of rotation, it is usual to attribute the main part of this rotation to the falling-back into the planet of matter which had been drawn out of it tidally, but had not sufficient angular momentum to form satellites. Jeffreys has calculated that Jupiter's present rotation could be produed by the falling-back of matter totalling one-fifteenth of th whole mass of the planet.

This certainly seems a large mass. Jeffreys, considering it to be inadmissibly large, has proposed replacing the tidal action of a second star by a grazing collision with a second star. The matter near the point of collision would then be caught between the upper and nether millstones formed by the two stars, and set into rapid rotation. This brings us very near to the " collision " hypothesis which was propounded by Bickerton of New Zealand in 1880; either hypothesis gives adequate rotation to the planets.

Professor H. N. Russel has drawn attention to a second, and perhaps more serious difficulty, which emerges from a study of the angular momentum of the planets round the sun.

Calculation shews that, if planets were to be formed at all, the second star must have passed fairly close to the sun's surface probably within two or three radii of it. A less close approach would have resulted merely in a rise and subsequent fall of tides on the sun's surface. Knowing the distance within which the second star must have passed for planets to be formed, we can calculate an upper limit to the angular momentum per ton which this star could have had around the sun. It is hard to see how the encounter can generate more angular momentum per ton than this in the ejected matter, so that we should expect that this same figure would set an upper limit to the angular momentum per ton of the planets. But in actual fact the planets all have substantially more angular momentum per ton than this expected upper limit -Neptune twenty-two times as much, Saturn twelve times as much, Jupiter nine times as much, and so on. To state the difficulty in more physical language, the whole encounter on which the tidal theory relies must have taken place well inside the orbit of Mercury; what force, then, can have projected Jupiter, Pluto, etc., out to where they now are?

Lyttleton following a suggestion of Professor H. N. Russel, has tried to find an escape by supposing that the sun was originally half of a binary system, the other constituent of which has been captured by the second star of the tidal theory. He believes that this gives an adequate account of the angular momentum of the planets, but Laytons and Hill have challenged his analysis, and the issue is still in doubt.

Milne has recently developed a new and very revolutionary system of dynamics in which angular momentum does not stay constant in the absence of external forces, but increases steadily with the time. This of course removes all the difficulties which arise from excess of rotation and angular momentum, not only from this problem, but from many other problems of cosmogony. But it has not so far gained many adherents.

While it has to be admitted that these questions of rotation introduce certain difficulties into the tidal theory, the many successes of the theory seem to me to suggest that it is nevertheless fundamentally on sound lines.*

*Lecture delivered by the author at the Indian Association for the Cultivation of Science.

Chemical Composition and Nutritive Value of Bananas

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BANANA is an important crop most successfully cultivated in hot and damp climate of all tropical and subtropical regions.

The northern limit of its cultivation is reached in Florida, Canary Island, Egypt and South Japan, and the southern limit in Natal and south Brazil.

Description of the Plant

The plants are gigantic herbs with what at first appears like a tall stem but which in reality is the base of the leaves one closely enveloped into another. A true stem develops at the flowering period which grows up through the hollow tube formed by leaf sheaths. The emergent end bears a tuft of a large number of tubular flowers encircling the stem top in bunches with a patch of protecting bract over each layer of floral row. The flowers in due course take the shape of banana fruits which form dense clusters.

The cultivated form of the plant is propagated entirely vegetatively, since the fruit usually contains no seeds. In one variety seeds are often to be found as hard round bodies in the flesh of the fruit. but in the rest of the order they occur with merely perisperm or growth of the nucellar tissue of the ovule.

The plants belong to the genus *Musa*, (natural order *Musacae*) derived indirectly from the word "Mocha".

Early mediaeval travellers generally used to call the fruit either "fig of paradise" or "fig of India."

The most generally used fruits are obtained from *Musa paradisica*, of which an enormous number of varieties and forms exists in cultivation. The subspecies *Sapientum* is the source of the fruit generally known as banana and eaten raw, while the name plantain is given to forms of the species itself (*M. paradisica*). The species is probably a native of India and southern Asia.

From the Indian standpoint some of the most important forms are:—Dâccâi, Martamân, Châmpâ, Kântâli, Râmkalâ, etc. The peel of the fruit while ripe generally exhibits brownish yellow colour, but there is a particular variety grown in India which retains its green skin when ripe. Râmkalâ, the characteristic high-class banana of Bombay, is of a very dark red colour while immature but it finally ripens into a yellowish red.

Bananas after mangoes are the commonest of all Indian fruits, while the coarser kind constitutes one of the staple articles of diet in many parts of India and Malay Peninsula. Just as wheat and barley have played their part in more temperate regions, so the banana has played its part in the tropics. It is said by some authors that the produce from one acre will support a much greater number of people than a similar area under any other crop. The fruit is obtainable in abundance at all seasons. In the winter months especially it provides an inexpensive food particularly needed in the diet often too low in fresh fruits.

In temperate lands a supply of fresh fruits is a luxury as a rule. The London poor have, however acquired the habit of giving their children bananas, because such fruit is cheap in London, which is the centre of distribution for the English fruit trade. Probably the first importation of bananas into the United States of America was made somewhat more than one and a quarter century ago. At that time thirty bunches were brought from Cuba to New York. In 1929 the

CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF BANANAS

total importations were sixty-five million bunches. Similar figures may be cited for countries of Europe. These facts indicate that banana though a native of the tropics is getting to be more and more a popular food in America as well as in Europe. American and English market demands have greatly accelerated the cultivation of bananas in Jamaica.

Nutritive Constituents and Caloric Value

From the standpoint of nutrition the banana is essentially a highly edible source of carbohydrate, comparable in its richness of foodstuffs with the most popular of fruits. The fat and fiber are negligible. The ash is important both in amount and constituent.

The banana has a high fuel value, yielding over four hundred calories per pound. A single fruit weighs on an average 101 grams and contains 100 calories.

An interesting comparison of the edible portion (average) of the banana with that of other fruits is given at the next column from the Bulletin, U. S. Department of Agriculture, Washington.

	Water.	Protein.	Fat. %	Carbo-hydrate %	Ash. %	Fuel value per lb. calories.
Bananas ..	75.3	1.3	0.6	22.0	0.8	460
Grapes ..	77.4	1.3	1.6	19.2	0.5	450
Cherries ..	80.9	1.0	0.8	16.7	0.6	365
Apples ..	84.6	0.4	0.5	14.2	0.3	290
Oranges ..	86.9	0.8	0.2	11.6	0.5	240
Peaches ..	89.4	0.7	0.1	9.4	0.4	190
Muskmelons	89.5	0.6	..	9.3	0.6	185
Strawberries	90.4	1.0	0.6	7.4	0.6	180

Protective Coating

Extensive bacteriological examination of bananas has been made in different stages of their maturation, all of which justify the conclusion that the inner portion of the pulp of sound bananas is practically sterile. A banana properly handled is uncontaminated by dirt and pathogenic germs. Even when bananas were subject to the exceptionally severe test of being immersed in fluids containing cultures of known organisms there was no evidence of a penetration into the interior. The probability of infection through the peel is, therefore, very slight.

Proximate Composition

The following figures indicate proximate chemical composition of fully ripe bananas:—

	Refuse. %	Water. %	Protein (N. X. 6.25). %	Fat. %	Ash. %	Carbohydrates. Total by differences incl. fibre. %	Fibre. %	Sugars as Invert. %	Acids as Malic. %	Fuel Value. Per 100 gram. Cal.	Per 100 pound. Cal.
Average ..	.. 33	74.8	1.2	0.2	0.84	23.0	0.6	19.2	0.39	98.6	445
Probable error	.. 2.6	2.4	0.2	0.2	0.11	..	0.3	1.7	0.08	..	..
Maximum ..	.. 40	83.4	2.0	1.4	1.4	..	1.8	25.7	0.55	..	..
Minimum	.. 23	65.4	0.8	.0	0.5	..	0.2	14.5	0.26	..	..
As purchased	.. ..	50.1	0.8	0.1	0.6	15.4	0.4	12.9	0.3	66	300
No. of Samples	.. 34	69	59	39	62	..	18	36	21	..	..

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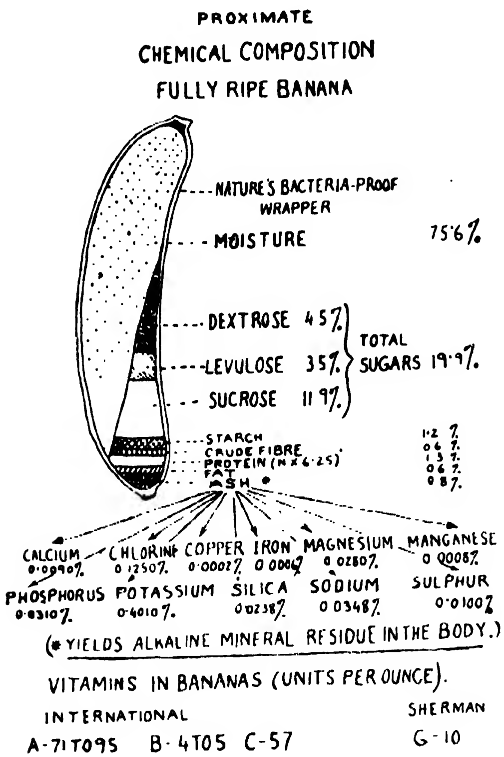
Bananas are richer in solids and lower in water content than other fresh fruits. But they have very little protein and fat. The green banana contains, in the part exclusive of the skin, about 1.5 per cent of protein, 20 to 25 per cent carbohydrate and almost all the rest starch. In the ripe bananas with the yellow-brown peel, the edible part contains somewhat less (16 to 19 per cent) of carbohydrate; but that which remains is now almost in the form of soluble sugars. Broadly speaking, the ripe banana is about one-fifth sugar, the green one-fifth starch. Most of the remainder of the edible pulp is water. Its small quantity of protein and fat enables the dietarian, as is often necessary, to increase calorie values, without appreciably adding the protein content. This is of great value in diseases of the kidneys.



Whereas five parts of potato protein may replace four of body protein in establishing body equilibrium, the protein of bananas is not so efficient. Yet in the tropical countries, such as the sea-coast of East Africa, the Congo and Pacific Islands, during the six months of the rainy season (in which the banana is ripe), it furnishes almost the exclusive diet of the natives. It is preferred to potatoes because it can be obtained almost without labour.

Mineral and Ash Content

Banana is rather similar to potato; the caloric contents are about equal; so are the nitrogen contents, the carbohydrate contents and the ashes.

The ash content of banana is higher than that of any other fruit. In the different varieties of banana mineral contents and acid remain nearly identical. Its mineral content is worthy of mention especially in view of the fact that iron, copper and manganese are present, iron being more readily assimilated in presence of the other two minerals. Chemical analysis shows that within 0.8% average ash content of fully ripe bananas, mineral constituents are present in the following proportion as per cent of the banana:—

Calcium ..	0.0090
Chlorine ..	0.1250
Copper ..	0.0002
Iron ..	0.0006
Magnesium .	0.0280
Manganese .	0.0008
Phosphorus	0.0310
Potassium .	0.4010
Silica .	0.0238
Sodium .	0.0348
Sulphur .	0.0100

A Source for Haemoglobin Formation

There is a preponderance of calcium and magnesium over phosphorus which makes the ash alkaline and so bananas help to combat a tendency towards acidosis. The minerals of banana have blood-building properties.

Periodic haemoglobin determinations made on many babies indicated that they maintained a comparatively high haemoglobin percentage while on

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banana-sugar feeding. This may be attributed to the iron, copper and manganese content of the banana sugar. Banana powder was examined for its available iron content both by a chemical method and by feeding experiments on nutritionally anaemic rats. The chemical dipyridyl method employed indicated a high degree of availability, 90 to 100 per cent of the total iron content (0.00245 per cent). The biological experiments showed that all of the iron in banana powder was available for the building of haemoglobin provided ample copper was supplied to permit complete utilization of the iron. The U. S. Department of Agriculture gives the following figures on the iron content of seven specimens of fully ripe, peeled bananas purchased in the months of February, April, and November;—

	Iron per cent.
	0.00031
	0.00048
	0.00026
	0.00037
	0.00173
	0.0008
	0.0005
average	0.00064

Alkalinity

A table of alkaline ash foods refers the degree of alkalinity of the banana as 5.56 c.c. N-NaOH per 100 gm. Bananas are included in a list of foods rich in sodium chloride.

The final products of metabolism of the banana in the body are alkaline. In diets in which banana forms a considerable part, the reaction of the urine is distinctly alkaline and for this reason it can be used to great advantage in cases of varying degrees of acidosis so commonly found among all classes of people.

Children from 5 to 13 years of age were studied in groups of four; two on mixed diet without bananas, and two on the same diet with 3 to 6 bananas substituted for a corresponding quantity of carbohydrate. After a suitable interval the diets of the pairs of a group were transposed. Representative samples of the food intake, the total urinary and faecal output of each child was collected for a four-day period. There was always a some what smaller daily volume of urine and a somewhat greater output of faeces in the banana-feeding than in the control periods, but never any diarrhoea on banana diet. The urine was always distinctly more alkaline with the banana food than with the control diets, as shown by pH values.

Meals with a high buffering value help to hold, and liberate slowly acid which serves to kill bacteria ingested one or more hours after the taking of a meal. In order that the bacteria may be killed, it is important that the gastric contents develop an acidity as high as or greater than pH = 2.

Albumen

After drinking contaminated liquids, the taking within a short interval of time another meal, perhaps well buffered and somewhat alkaline will tend to wash living bacteria, left behind in the nasopharynx or oesophagus by the infected meal, directly into the bowel. It has been found that banana pulp serves as a well-buffered meal to hold HCl in the stomach. 100 gms. of banana dry contain 1.5 gm. of albumen. If it is desired to serve a diet very low in albumen, some physicians resort to a daily *menu* of 1,400 gms. of banana pulp which give 19 g. of albumen, 1.8 g. of salt, 1,225 calories. This is specially required for patients afflicted with diabetes.

Sugars

Carbohydrate of bananas comprises about 22 per cent of the total weight of ripe banana. This consists of a mixture of sugars chiefly sucrose, dextrose and levulose, which is very well digested and absorbed even by infants and young children with gastro-intestinal disturbances. A typical analysis of the carbohydrate in edible portion of banana is given below:

Glucose	5.82%
Fructose	3.78%
Sucrose	6.58%
Starch	3.02%
Total available carbohydrate ..	19.20%

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Transformation of Carbohydrate

The first product of photo-synthesis that can positively be identical in the veins of the leaves is saccharose. It then reaches the petiole concurrently with transformation into invert sugar. The inversion continues throughout the length of the petiole to such an extent that the saccharose, which predominates in the veins, forms but a small portion of the sugars present at the base of petiole.

From the base of petiole the mixture of soluble sugars is transported to the peduncle of the bunch, without undergoing any notable modification, and penetrates into the fruit.

The ripening process in banana is characterized by the starch which is present in the fruit pulp in large quantities, being gradually dissolved through enzymic influence and changed into sugar. In the ripe banana the originally harsh taste vanishes, and is replaced by the well-known and most agreeable banana aroma, due primarily to slight amounts of amyl acetate. Little acetaldehyde is present in frozen bananas, the ripening process of which has been interrupted; a much larger amount is noticeable in ripe bananas.

Studies on Ripening

Analysis has shown that during ripening the banana starch is transformed into cane sugar and the cane sugar into invert sugar, that there are important changes in the character of the tannin compounds, and that other changes occur, brought about by the production of aroma and flavour and in other ways. Studies made with banana-ripening by the help of respiration calorimeter show that the ripening changes progress regularly to a maximum and then decline, that at its greatest intensity heat produced is approximately one-half to one calorie per hour per kilogram of bananas. The heat liberated is a measure of the activity of one or more of the ripening processes.

Progressive maturity causes constant changes in the carbohydrate content from starch to sugar during the ripening process in a normal form even after the fruit has been detached from the stem. Inversion of saccharose, however, proceeds very slowly; it seems that the premature detachment of the fruit from the stem is respansible for this. Complete inversion will take place only under favourable temperature conditions.

Ripening experiments made on green bananas which were carried out in a large respiration calorimeter or in a specially designed ripening chamber indicate that the usual carbohydrate changes--saccharification of starch with formation of sucrose and invert sugar, and consumption of sugar in respiration—proceed with uniformity in bananas of different bunches. The period of most rapid respiration corresponded closely with that of most rapid starch hydrolysis. The quantities of ash, protein and ether extract undergo but slight changes during the ripening of the bananas. Pentosans decrease markedly in the pulp, but remain little changed in the peel.

Effect of Ethylene on Ripening

Bananas ripening in an atmosphere containing 1:1000 parts of ethylene turn yellow at a somewhat rapid rate than do the controls. Such bananas also show a slightly greater increase in sugars and decrease in starch from day to day than do the controls. Concentrations of ethylene ranging from 1:100 to 1:10,000 all seem equally effective in bringing about the small differences observed. Ripe bananas have 12-20 per cent of total sugars. 10-14 per cent of sucrose, and less than 1 per cent of starch. Respiratory activities of bananas treated with ethylene differ little or not at all from those of the untreated ones. Rarely is there found a bunch of bananas which is in a quasi-dormant condition and in this case ethylene stimulates an immediate commencement of ripening.

Enzymes

During ripening the starch in the banana is converted into sugars by means of enzymes. A ripe banana contains as high as 18 per cent of reducing sugars. The enzyme capable of hydrolysing the starch of banana and of converting cane sugar to invert sugar is destroyed by temperatures above 150°F. The properties of the gel obtained from banana extract by treatment with calcium-salts and alkali or with pancreatin and of banana sucrose were studied. It was shown that different substances

were involved in the gel formation and in the enzyme actions, although boiling the solution destroyed both properties.

The sucrose of unripe and ripe bananas was extensively studied. With ripe bananas both soluble and insoluble sucrose preparations were obtained. Conditions for converting the soluble into an insoluble form were found. The action of the sucrose preparations as far as the hydrogen ion concentration for maximum action relation is concerned is similar to the behaviour of the yeast and the potato sucrose. The optimum hydrogen ion concentration for the activity of sucrose from banana was found to be $p\mathrm{H}=4.0$. The banana sucrose is definitely retarded by the presence of citrate, phosphate, phthalate and acetate buffers. This retarding effect increases with increase in buffer concentration. It was found that the sucrose activity of banana extracts increased as much as 40-160 per cent upon standing for a short time and then decreased again. The nature and amount of increase was found to be dependent upon the state of ripeness of the banana at the time the extract was made. Cause for this increase could not be determined. Extensive investigation has failed to show the presence of amylase in the banana, although the conversion of starch to sugar in this fruit is remarkably rapid.

Malic Acid

Malic acid which is easily and completely utilized was found to be the only non-volatile organic acid present in the ripe banana.

During ripening of the banana the malic acid content increases to a peak, then gradually decreases as the fruit matures. At the stage of ripeness at which bananas are usually eaten the malic acid content is approximately 0.3%.

Fatty Acid

The amount of fatty acids liberated by the hydrolysis of banana starch free from extraneous fatty material has been determined to be 0.2%. The fatty acids have been found to consist of a mixture of palmitic, oleic, linoleic (linolic) and linolenic acids together with a very small amount of phytosterol.

Tannin

The tannin content of bananas remains unchanged during the ripening process. Unripe bananas are characterized by their high starch content, their astringency, and lack of sweetness. The ripe fruit, on the other hand, has little starch and is not noticeably astringent. It is claimed that this astringency is due to tannin in the unripe fruit which is in the soluble form. As the fruit ripens the tannin becomes insoluble, or "fixed," and hence cannot be tasted in the ripe fruit.

Pectin

Pectin is usually classed with hemicellulose and cellulose as an unavailable carbohydrate.

The total pectin content of the banana is not great (about 1 per cent of the fresh pulp) but what relation this substance bears to the digestibility of the fruit is not very definitely known.

That the buffer action of the pectin plays only a minor part in the therapeutic action of apple and banana diets is proved by buffer curves. However, certain workers have given credit to the pectin of bananas and apples for the beneficial action of these fruits in the treatment of diarrhoea of both children and adults. The galacturonic acid content of pectin has naturally been assumed to have a detoxifying action similar to glucuronic acid. Other authorities find that no utilizable carbohydrate is derived from pectin by diabetic dogs, but that there is an antiketogenic action which indicates that pectin is not as unavailable as has been assumed. Some authors suggest that the resistance of banana-fed rats to orally ingested *B. enteritides* may be due in part to the pectin content.

Latex

When the peel of a green banana is punctured, a sticky, milky fluid oozes from the wound. This substance very closely resembles chicle.

Vitamin

Bananas contain fair amounts of vitamins A, B, C, G, and also some E. It is an excellent source of

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vitamin A, a good source of vitamin B, but deficient in vitamin D.

THE VITAMIN TABLE FOR BANANAS

Vitamin A	..	..	+ to + +
Vitamin B_1	..	..	+
Vitamin B_2	..	..	+
Vitamin C	..	..	+ +
Vitamin D	..	..	low
Vitamin E	..	..	+ +
Vitamin G	..	..	+ +

+ signifies that materials contain the vitamin;

+ + it is a good source of vitamin.

The following figures indicate vitamin rating for bananas:

		per ounce. Units International.	per ounce. Units Sherman.	Sherman Units. per banana.	per lb. of bananas.
A	..	71 to 95	100	360	1600
B	..	4 to 5	8	..	..
C	..	57	5	20	80
D	..	..	..	..	..
E	..	..	..	..	..
G	..	..	10	35	160

Eighty-seven grams of banana yield about 250 ts of vitamin A; 270 grams yield about 50 units of vitamin B (B_1). A similar quantity of banana gives about 30 units of vitamin C.

According to a table furnished by Jung 100 gms of banana contain 10-20 units of vitamin B_2. The vitamin C content of foodstuffs was calculated on the basis of guinea-pig units. Tillmann's table records 30 units for 100 gms of banana. Expressed in milligrams per 100 gms. of fruit, the vitamin C content of the banana is 2 milligrams per cent as opposed to 2.10 milligrams per cent with Tillmann's method.

György found a vitamin H, the lack of which is apt to produce cutaneous affections similar to seborrheic eczema. A special minimum substance was discovered which cured this affliction in the rat within two or three weeks. This substance is named H factor, and the daily curative dose present in the banana is 4 to 5.0 gms of fresh fruit.

The following figures are given showing the contributions to the diet of the banana, orange and apple (medium size):—

	Cal.	Pro.	Ca.	P.	Fe.	Vit. A.	Vit. B.	Vit. C.
Orange	0.8	0.5	3.1	0.7	0.6	1.4	2.1	92.0
Banana	1.0	0.5	0.4	0.7	1.2	3.6	1.0	17.0
Apple	0.8	0.2	0.4	0.4	0.8	0.7	1.2	10.4

The above figures represent "shares":—

1 Energy share = 100 calories.
1 Protein share = 2.5 gm. or 10 calories.
1 Calcium share = 0.023 gm.
1 Phosphorus share = 0.044 gm.
1 Iron share 0.0005 gm.
1 Vitamin A share = 100 Sherman Units.
1 Vitamin B share = 30 Sherman Units.
1 Vitamin C share = 1 Sherman Units.

Being rich in vitamin A, bananas help normal tooth development, are a dietetic factor in regard to the length of life. Experiments with young rats have shown that the disease preventing, or healing, component of the A-vitamin in the banana is very active, while the components which increase weight act rather more slowly, but are present in sufficient quantity. The daily dose for an experimental animal was 1 gm. banana per 50 gms. body weight. With a child of three years, whose weight is about 12-14 kilograms, the daily banana intake should be 240-280 gms or 4-5 bananas. Considerably smaller quantities, however, ought to be sufficient.

Banana and Milk

Combined with milk, banana produces an almost completely balanced ration. Milk is also a good source of Vitamin A. Bananas and milk offered a means for measuring the effect of increased intake of vitamin A obtained from natural food sources. While the fat content of the banana is negligible as a source of calories, it is important as a holder of the fat soluble vitamin A. Milk, although the most important and satisfactory article of food for growing children is far from a complete food. It is markedly deficient in carbohydrate. Furthermore, pasteurization destroys the important vitamin C.

Thus, it is necessary to supplement vitamins from other sources.

The following table shows how the addition of banana restores to pasteurized milk its vitamin values with increase of vitamin C:—

	Vitamin A.	Vitamin B.	Vitamin C.
Milk (Whole) ..	**	***	*
Milk (Pasteurized) ..	****	**	..
Milk (Pasturized) with banana	*****	***	**

Eddy and Kellogg state that the banana has about the same vitamin B value as tomato juice. Comparing the dry weights of materials, orange was found to contain one-fifth as much vitamin B_1 as yeast; tomato slightly less than one-tenth; banana one-twentieth, and apple still less. Orange, tomato and banana were found to be just less than one-tenth as rich in vitamin B_2 as yeast. The addition of vitamin B to the diet in the form of banana may cause a prompt and striking improvement of persons suffering from celiac disease.

Bananas, Orange juice and tomato juice are very rich in vitamin C. Patients suffering from chronic ulcerative colitis are given one very ripe banana, ½ glass of orange juice, 2 tablespoonfuls of vegetable purée, daily.

Lewis concludes that with a basal diet adequate in all respects except vitamin C, 10-15 gms. of raw banana per guinea-pig per day sufficed for growth and protection against scurvy. Givens, McClugage and Van Horne cosidered 10 gms. to be the minimum protective dose and the same amount was reported by Jansen and Donath for two varieties of Indian bananas. Eddy considers 5 gms. of banana to be the minimum protective dose, and 8-10 gms. the optimum dose for growth stimulation as well as scurvy prevention in guinea-pigs. Bananas baked with the skin retain their antiscorbutic properties better than when baked without the skin, probably on account of the protective action of the skin against oxidation. Eddy and Kellogg reported the cure of scurvy in eight months' old baby by a banana milk mixture made by whipping 200 gm. of ripe raw banana into 570 c.c. of milk. This was fed in 120 c.c. portions every four hours with no resulting digestive disturbances. Ripe bananas or if cooked when partially ripe are readily digestible even by infants, and are valuable in modifying infant milk formulæ because of the unique combination of readily assimilable sugar and vitamin C, and are an aid against constipation. Experimental results showed that the smallest amount of banana which keeps guinea-pigs (300 gms. weight) from developing scurvy, is 40 gms. a day.

There is no reason to assume that artificially ripened bananas are less rich in vitamin C than those which are almost ripened entirely on the tree.

Göthlin believes that the lowest protective quantity for prevention of scurvy for twenty-four hours would be present in 140-200 gms. of either apples or bananas in a raw state.

Only 5 gms. of yellow banana are adequate to prevent scurvy in guinea pigs; this however, is not true in the case of red and green (the particular variety grown in India which retains a green skin when ripe) bananas. Ten gms. at least of red banana pulp were required for the purpose, while in the case of green banana pulp even 15 gms. proved insufficient.

Evans, Herbert McLean and Burr report that one third of a banana daily, averaging 27 gms., when consumed *ad libitum* separately from the basic ration, bestowed fertility in cure experiments. In describing their animal experiments the authors report that three rats were reared on a modification of the basic ration and that after sterility was proved in each case by the occurrence of a resorption gestation, they were fed daily apart from the basic ration, fresh crushed banana *ad libitum* (the animal consumed about 27 gms. of the fruit daily). They were then bred to males of proved fertility, a normal gestation resulting in each case.

Effect of Taking Unripe Bananas

Inasmuch as bananas are commonly eaten uncooked, it is obvious that more or less starch will be ingested, if the fruit is not ripe, *i.e.*, if the skin has not begun to shrivel and darken. Raw starch may be singularly irritating to the alimentary tract

of man and is at best poorly utilized, whether it be ingested in the form of uncooked potatoes, chestnuts, bananas or other native starch foods. No one would advise the use of uncooked potatoes; yet many people eschew a throughly ripe banana in the belief that this wholesome fruit is rotten when the skin becomes darkened, whereas they eagerly eat the yellow green starch bearing fruit at the stage of incomplete ripeness. Green bananas, like green apples, are unwholesome so long as the starch has not been adequately converted into sugars in the ripening process. The delicious and innocuous ripe banana should not be made to suffer in its dietetic reputation because of the ignorance of the consumer.

Besides taking in the raw form bananas are often baked and cooked, powdered and mixed with various vegetables, fruits and food of animal origin. These have got their particular degree of efficacy in increasing or decreasing the nutritive value and digestive property of the food produced. It will be too elaborate to deal with all these points here and probably a vast field of experimentation is still unexplored in this direction.

Extensive research work on banana therapy has been already published and it has been found that banana is very effective in combating scurvy, dysentery, diarrhoea, diabetes, kidney troubles and many other diseases.

From what has already been said it can be concluded that banana is a cheap fruit, available at all seasons, palatable, nutritions, easily digestible and of high therapeutic value.

Recent Advances in the Study of Plant Growth Hormones

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THE conception of a growth hormone can be traced as far back as 1882 to the work of Sachs, who suggested that leaves form "Organ-forming substances" and that plants contain specific substances which control the formation of roots. The conception has rapidly developed in recent years and the role of growth hormones in the growth of plants and root formation has been clearly demonstrated and a large number of synthetic organic compounds have been investigated which influence markedly the growth of plants. They are termed under the general name Auxins. Kögl[1] with his co-workers has been able to seperate, purify and determine the chemical composition of α-auxin $C_{18}H_{32}O_5$; β auxin $C_{18}H_{30}O_4$; and heteroauxin $C_{10}H_9O_2N$, *i.e.*, β-indolyl acetic acid. They all have a similar effect on the stretching phase of the plant growth. Avery and co-workers[2] have added indole acetic acid, potassium indole acetate, indole butyric acid, potassium indole butyrate, naphthalene acetic acid, potassium napthyl acetate, and indole propionic acid as growth-promoting substances. Snow[3] has added benzoyl oxide and benzoyl peroxide. Crook, Davis and Smith[4] have reported β thionaphthene acetic acid to be effective in concentration greater than one part in 70,000.

It has been shown that pure auxin prepared by Kögl and co-workers is active in root formation (Thimann and Went, 1934).[5] Out of the above-mentioned substances the effectiveness of β-indole acetic acid in root formation has been shown by

RECENT ADVANCES IN THE STUDY OF PLANT GROWTH HORMONES

Laibach,[6] Thimann and Koepfli,[7] and Fischnich.[8] In addition to a number of synthetic substances, Hitchcock and Zimmermann[9] and Pearse[10] have shown that indole butyric acid and α-naphthalene acetic acid are very effective in root formation.

Quantitative Test

Standard avena test (Went,[11]) It is known that a growth hormone, when applied to the stump of a decapitated Aven coleoptile, moves downwards into the plant tissue and causes the longitudinal growth of the coleoptile. But when applied to one side only, it causes a lateral growth on that side alone, which results in a curvature on the other side, *i.e.*, negative curvature. On the basis of this behaviour Went formulated his technique of auxin test. Oats are germinated in a dark room at 25°C and 90 per cent humidity. When the coleoptiles have grown to about 3 to 4 cms. in length, they are decapitated, about 0·5 cm. of the coleoptile tip being removed. Standard size agar blocks are prepared in which the growth hormone is allowed to diffuse from the material to be tested for the hormone. These agar blocks are then placed unilaterally to the deaptitated avena coleoptile for tests. After a time the curvatures are photographed and measured. It has been found that the angle of curvature under certain limits is proportional to the concentration of the hormone present[11, 12, 13]. An automatic Photokymograph has been described by Schneider and Went[14] to record the curvatures.

The standard method is modified by Van der Weij[15] who introduced a second decapitation one hour after the first to prevent further regeneration of auxin. Skoog[16] modified the standard test by removing the entire seed after two days of germination, with the exception of the lower half of the scutellum. He has suggested that by this deseeded method the possibility of regeneration of auxin-precursor in the seed is prevented and a more sensitive test plant is obtained.

Pea test method (Went 1934)[17] is also based on curvature method. Here stems of etiolated *Pisum sativum* seedlings are obtained. 5 cm. of the tip of stem is removed and then 2 to 20 cm. long pieces are taken and split longitudinally at the tip for one to three cm. The two halves of the split portion curve outwards in aqueous solution; but in presence of auxin and at 25°C and after about half an hour the two halves begin to curve inwards. This test can be made quantitative by using a series of concentrations and finding the minimum concentration when the action just begins.

A test method for Rhizocaline. described by Went[18] is based on the formation of roots in treated and untreated decapitated shoots of *Pisum sativum*. The stem is prepared by cutting the shoot when it has reached a height of 10 to 15 cm. germinated under controlled conditions of light and temperature. The first leaf appears under the third node and it is decapitated just below it. Thus a piece of stem is obtained containing the second and the third internodes. The base of the stem is then kept in water for four hours and then in 0.05 per cent potassium permanganate for four hours to free it from naturally occurring rhizocaline. After washing it free from potassium permanganate the apical portion is split longitudinally and then placed for 12 to 15 hours under standard conditions in rhizocaline solution. After rinsing the tip in water the base is supplied with a 2-percent sucrose solution for six days and then with tap water. After all this treatment the number of roots produced are counted 14 days after the treatment with rhizocaline. The rhizocaline unit Went described as the quantity of the substance which produces one root in excess of that produced in untreated control ones.

Sources and distribution

It has been demonstrated by various workers that terminal and lateral buds, cotyledons and leaves are among the most important sources of auxin. Thimann and Skoog[19] on *Vicia faba*, Uhrova[20] on *Bryophyllum*, Avery[21] on *Nicotiana*, Dollfuss[22] on *Podophyllum*, Goodwin[23] on *Solidago* and Avery and Co workers[24] on *Aesculus and Malus* have shown the presence of auxin in leaves. The amount of auxin and its diffusion from the leaves is correlated with the age of the leaves. Diffusion is very small in early stages, then increases to a maximum which is coincident with the rapid growth of the leaf and then falls off with maturity. The concentrations of growth hormone at different periods in the life cycle of *Zea mays* have been studied by Laibach and Meyer.[25] Zimmermann[26] (1936) has studied the concentration of growth

hormone is several woody species. The presence of growth hormone in stem is not yet definitely known.

Studying the distribution of growth hormone in the coleoptile and radicle of Avena seedlings Thimann[27] has found the presence of growth hormone in appreciable quantity in the lower part of the coleoptile. The concentration decreases regularly from the tip to the base from 0.69 units to 0.19 at the base. The same is the case with the root, falling from 0.43 at the root apex to 0.26 in the physically uppermost region of the root. Root-forming hormone has been obtained from rice polishing, urine, wheat embryos and from leaves cf *Helianthus Prunus and Malva* (Thimann and Went).

The presence of growth hormone in shoot tips is associated with growth and light. There is a close parallelism between growth intensity and growth hormone concentration (Zimmeramann).[26] Growth hormone is detectable in increasing amount during the swelling of terminal buds of *Aesculus* and *Malus* (Avery, Burkholder and Creighton).[24] Elsewhere Avery and co-workers[27] have demonstrated the disappearance of growth hormone in darkness and in depleted food supply. The plants under normal day and night conditions but under reduced CO_2 supply also form smaller quantities of growth hormone. Under reduced CO_2 but in continuous light of defferent intensities, growth hormone production is proportionately greater in higher intensities of light. Higher growth substance concentration is found under exposures of red and blue part of the spectrum.

Transport

It has been known from a long time in ringing experiments root formation takes place at the upper end of the ring supporting the view that the root forming substance travels downwards in the phloem from the apical region and accumulates at the upper end of the ring. In all cases of auxin it is found that auxin travels downwards from the apical region even in cases where initial auxin concentration in the basal part is three times that in the upper (Van der Weij).[28] So transport is here independent of the concentration gradient. Olson and Buy[29] reported that a growth substance is present in the egg cells of *Fucus* and plays an important part in its polarity. In relation to the seasonal activity of Cambium to growth hormone (Snow)[3] a concentration gradient has been observed. Pearse[10] also observed a concentration gradient effect and root formation throughout the length of *Salix vitellina* (Willow plant) cuttings when indole butyric acid in lanolin was applied at the apical portion, the number of roots gradually decreasing from apex towards the base.

Function of Auxin

Auxin plays a decisive part in the stretching growth of stems, apical swelling and root formations. But an inhibitory action in the case of lateral buds of *Vicia faba* has been noted by Thimann and Skoog[30],[10] and Skoog and Thimann.[31] They have found that auxin formed in the apical buds is responsible for the inhibition of the lateral buds. When the apical bud is removed and agar block containing auxin of the same concentration which would have been present in the apical bud, is applied, the lateral buds are also inhibited. Growth hormone is associated with lateral buds only when they are in active stage of growth. When the lateral buds grow and produce auxin it is found that adjacent buds are retarded in their turn. The significance of this inhibitory action is discussed later under the nature of auxin reaction.

As many workers, Priestly,[32] Wight,[33] Brown,[34] have shown that resumption and seasonal activities of cambium is closely associated with bud development, it is therefore to be expected that in addition to other factors, growth hormone may play a definite role in the activation of cambial activity. It has been demonstrated that the cambial activity is initiated at the level of the terminal buds in the spring and spreads basipetally. Along with this is also observed a gradient of hormone concentration down the stem (Snow).[3] The hormone produced in the expanding buds move basipetally in stems before there is any indication of cambial cell division. Hence it is probable that growth hormone initiates cambial activity.

Nature of Auxin Reaction

Much cannot be said on the mechanism of auxin reaction in relation to the incidence of growth in

plants. That is of a very complex nature is undoubtedly true, consisting of a chain of reactions brought about by more than one factor. The view of the stimulatory nature of auxin is advanced by Fitting.[35] It is said to cause the liberation of energy in the system. But the evidence obtained from a detailed study of auxin behaviour is against it. It has been found in almost all cases of growth substance that per mol. they all cause the same amount of growth under strictly comparable conditions. It leads therefore to the conclusion that the reaction is of a chemical nature where auxin molecules take part (Went),[14] and not of a stimulatory nature. Went[11] gave the idea of a second factor-- "Zellstreckungs-Material" *i.e.*, cell stretching material supplied by the roots and moving from the base to the apical region, which is necessary for the auxin reaction. Laibach[6] and Skoog[16] also held the opinion of a second factor to which they suggested the name of auxin precursor. Therefore it is suggested that a second factor is necessary for the auxin reaction and auxin alone cannot cause the elongation of stem or swelling of bud and root formation. In connection with this food factor the interdependence of auxin and sugar for growth has been shown by Schneider[36] Went[11] and the role of salts in the response of Avena eleoptile to auxins has also been pointed out by Thimann and Schneider.[37] The food factor or auxin precursor, whatever name we give it, is not a simple factor, but a very complex one and sugar is a very important component of this food factor complex. Schneider demonstrated that for sub-optimal concentration of sugar and auxin, an increase in concentration of either gives an increase in the growth rate and its magnitude is proportional to the products of the logarithms of the concentration. Sweeny and Thimann[38] working on the effect of auxins on protoplasmic streaming have shown that low concentration of auxin (which is capable of growth acceleration) also accelerates streaming; but in higher concentration and in presence of limited oxygen supply it is retarded. They suggested that in the system an oxidative process is accelerated by auxin which controls the rate of protoplasmic streaming. As protoplasmic streaming is associated with growth, it is probable that it controls the growth rate and the substrate for this process is probably sugar. They held the view therefore that in auxin induced reaction the effect on protoplasmic streaming precedes that on growth. Similar view is put forward by Bonner[39] (1933, 1936) that the action of growth hormone in *Avena* coleoptile depends upon a process of respiratory nature though of a relatively small magnitude.

Recently Went[14] explained the auxin reaction on a double factor scheme. He suggests that the action of auxin is of secondary nature, depending upon independent specific factors. These factors he names Calines which are of hormonal nature and are formed and stored in one part of the seedling and are effective in another part, eg. caulo-caline (factor for elongation and swelling) is formed in the roots and cotyledons have only a small storage; phyllo-caline (leaf growth factor) is stored in cotyledons, but is also present to some extent in stem. Went has demonstrated the presence of these calines by decapitating different parts of seedlings (removing the sources of calines) and found deficient growth of these parts even in presence of auxin. So auxin is effective only in presence of these calines. The relation of auxin to different calines is not clear, but the relation of auxin to rhizo-caline and caulo-caline is clearly demonstrated by experiments. Thus the root formation at the base of lemon cuttings (Cooper)[40],[41] and in Willow cuttings (Pearse),[10] when auxin is applied at the apex is due to the accumulation of rhizocaline at the base of root formation. So the auxin gradient in the stem causes an accumulation of rhizo-caline which is responsible for root formation. Auxin therefore only brings about a redistribution of root forming hormone.

The phenomenon of inhibition of lateral buds observed by Timann and Shoog is explained on this basis of redistribution of caulo-caline by auxin. If auxin produced in the apical buds causes caulo-caline to move upwards in the stem and to accumulate at the place of auxin production, that is, apical buds, then the lateral buds which do not get caulo-caline cannot grow. But when apical buds are removed the lateral buds with their slight auxin production can direct caulo-caline and begin to grow. The close relation between sprouting and root formation is also therefore evident (Cooper).[41]

On the assumption of this second growth factor, Calines, it is possible to explain some of the observed facts; but the modification in Went's view from Zellstreckung-Material to food factor and recently to calines of hormone nature, shows that much more experimental work on this aspect is needed before an analysis of the different processes induced by auxin can be appreciated. The association of auxin with active growth, the rate of which is controlled by a set of internal and external factors is a complex physiological process and to explain such a system by assuming the presence of another set of hormones, the existence of which we cannot at present directly prove, are problems which obviously require further investigation and elucidation.

Summary

1. Many synthetic substances have been added to the list of growth hormones. Modified Standard Avena Test has been recommended by having a second decapitation one hour after the first. It is also suggested that a deseeded seedling gives a more sensitive test plant.

2. Auxin is always associated with growth, and is formed and stored in one part and is effective in another part. The terminal buds, the lateral buds, the cotyledons and leaves are amongst the most important sources of auxins in plants. The amount of auxin and its diffusion from the leaves is correlated with the age of the leaf.

3. Auxin always moves basipetally down the stem from the apical region even when the initial concentration at the base is higher than that of the upper part. While moving downwards it forms a concentration gradient.

4. The association of cambial activity and bud development suggests the possibility of the influence of hormone in cambial initiation in the spring.

5. The nature of auxin reaction has been recently explained by Went on a double factor scheme. He suggests independent specific factors of hormone nature, naming them different Calines responsible for stem elongation, bud development and root formation and auxin playing a secondary role in diverting and redistributing these calines in plants. On this basis the formation of roots, the inhibition of the lateral buds by auxin and the close relation between sprouting and rooting have been explained.

6. It seems on the basis of our present knowledge that auxin induces a chain of reactions in a system where many internal and external factors play part and it has been demonstrated that sugar at least is one of the necessary components of such a system.

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The Nature of "Agaru" Formation

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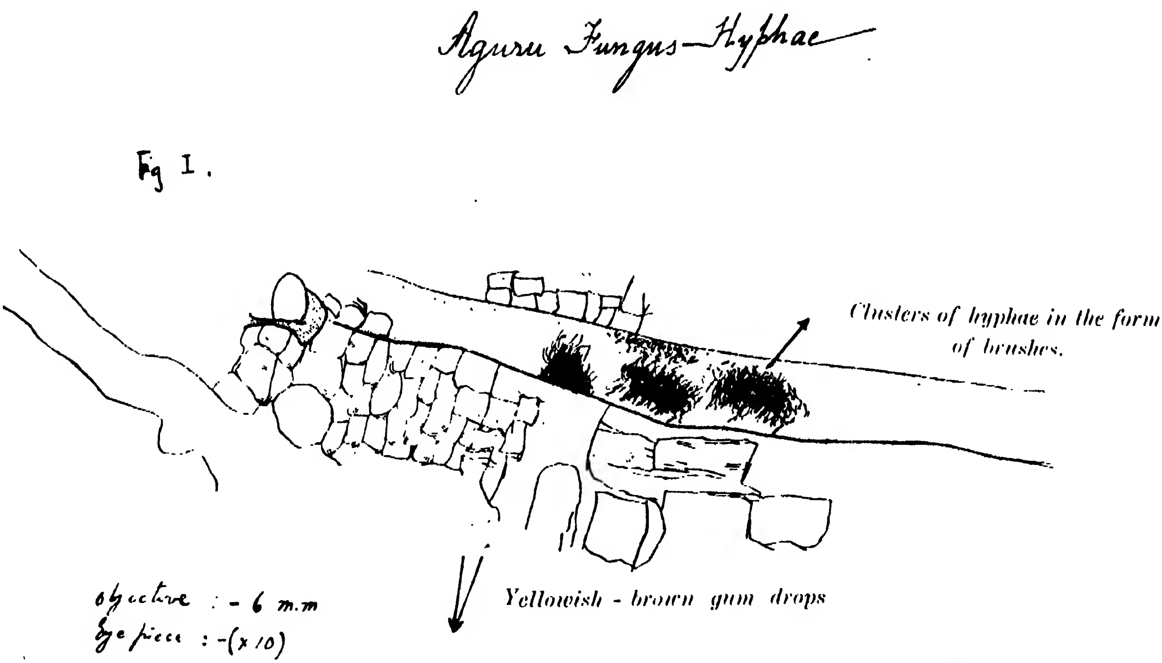
Agaru is collected from trees of *Aquilaria agallocha* Roxb. (Nat. Order *Thymelæaceæ*), which are sparingly distributed in Assam Garo Hills (Tura), Sibsagar, Sylhet, Tipperah Hills, Bhutan and Martaban Hills (Burma). Healthy trees of *A. agallocha* do not bear *agaru*, the *agaru* bearing tree has a distinct diseased appearance at the top and in the side branches, and *agaru* is collected in quantity only when such tree is either completely or partially (*i.e.*, branches, top etc.) killed. It is the opinion of local Garos who work with *Agaru* that the tree producing *agaru* ultimately dies, and as a matter of practice, no tree is usually cut or felled unless it shows outward signs of disease. But sometimes by mistake they cut and destroy a number of healthy trees suspecting *agaru*-formation; thus, the number of trees in the forests, which are limited and usually grow at distances from one another, is being gradually reduced and there is no regular plantation to increase their number. I learn that recently a nursery of about 100 shrubs has been raised. In a tree *agaru* is usually found in forks or at the junctions of branches with the stem. The disease usually takes some time to make itself manifest, hence *agaru* is hardly found in young shrubs. *Agaru* is highly prized in the market, true *agaru* is sold at Rs 16 to Rs 20 per seer, at present it is a chance product as no means of artificially increasing its production are yet known.

Dr Hooper, late Reporter on economic products of India, has recorded in the *Agricultural Ledger*, 1904, No. 1 that the wood of *Aquilaria agallocha* under certain conditions becomes gorged with a dark resinous aromatic juice and that the portions thus impregnated constitute the commercial *agaru*, which is esteemed in proportion as it abounds in resinous matter. The average yield of a mature tree is 6 to 8 lbs. and an exceptionally good tree may afford as much as Rs. 300 worth of *agaru*. The exact cause of its formation has not been ascertained yet.

Some years back in 1925 at the instance of Mr F. Trafford, the then Conservator of Forests of Assam, I began investigation of *agaru* wood; samples of wood from different localities and local information about *agaru* were sent to me from time to time by late Mr B. Sen Gupta, Mr J. N. Das, Dr N. L. Bor, Mr C. J. Rowbotham, Mr C. G. M. Mackarness, Mr W. R. Martin, Mr A. R. Thomas and other officers of the Forest department of Assam. On enquiry I learnt that the Bengal Chemi-

cal and Pharmaceutical Works of Calcutta get their supply of *agaru* wood from Sylhet (village Sujanagore). Sections of the diseased wood showed drops of yellowish-brown gum almost in every cell, a fungus-mycelium was found close to the clotted areas where there was a massive accumulation of gum-drops; in the cavities produced by the disintegration of wood-elements there were clusters of thin and narrow hyphae here and there in the form of brushes (fig. 1). Sections were cut from successfully grown in artificial medium (malt-extract agar) and its complete life-history was studied; it belongs to the group of ***Fungi Imperfecti.*** A short account of the investigation was communicated and read at the Bombay sitting of the Indian Science Congress in January 1926, it has been published at p. 224 of the ***Proc.*** 13th. Ind. Sc. Congress. Inoculation-experiments to produce the formation of *agaru* in healthy trees by this fungus-attack could not be carried out for want of *A. agallocha* trees in Bengal; some seedlings were imported from Assam and planted in our College-



various parts of pieces of *agaru* wood from different localities and in each case the same fungus with closely septed hyphae of dirty-brown colour could be traced. The wood of the clotted areas showed delignification by patches (fig. 2), dark and white layers regularly alternating. The general effect on wood agrees in all particulars with that produced by wood destroying fungi on timber-trees (*c.f.* A. S. Rhoads. New York State College of Forestry, Syracuse University, *Technical Publication*, no. 8, vol. XVII March 1917 and D. V. Baxter-Pap. *Michigan Acad. Sci*, Vol. III-1923). The fungus was

FIG. 2.

Objective—no. 7 of Leitz eye-piece—(X10).

Long. Section of the Agaru-wood showing delignification, septed hyphae represented in deep-black.

Garden but they did not thrive well and ultimately succumbed. Pure cultures of the fungus were from time to time sent to the forest-officers of Assam (Garo-Hills, Sibsagar, etc.) for inoculation on trees in their vicinity, but they could not satisfactorily proceed with the work. For the ultimate solution of the problem a number of trees should be available close to our place. It is very encouraging that the present Superintendent of the Royal Botanical Garden, Shibpur, Dr K. P. Biswas, is trying in right earnest to grow some plants from Assam in his garden and also at Mungpoo Cinchona-plantation for my work with the kind help of the Conservator of Forests, Assam and Mr A. Das I.F.S. (retired) now working at Shillong on "Flora of Assam." Of course, it will take a number of years hence before they are fit for the inoculation-stage.

Records of the Royal Society of London

THE Booklet, *Notes and Records of the Royal Society of London*, No. 1, April 1938, published by the Royal Society of London replaces the former publication of the Royal Society, titled *Occasional Notices* which described the activities of the Society, because it was felt that 'such a periodical might usefully include information of historical interest which would not be printed in either *Philosophical Transactions* or *Proceedings*.' It will be issued in April and October of each year, the former number being devoted to an account of the Anniversary Dinner, elections to fellowship and general information relating to the winter half of the session and the latter to an account of the two soirées and general information relating to the summer half of the session.

The *Notes and Records* will prove to be of considerable interest to those who have passed through the last four years' thrill of Academy-building in India. The information that it seeks to give is divided into 21 heads. It includes a list of the 20 new fellows elected on March 7 and also one of those among the fellows who died during the year (15) Last year's loss to the Society due to the death of its fellows was specially severe in view of the passing away of such eminent scientists as Lord Rutherford, Sir J. C. Bose and Dr G. E. Hale.

The society received during 1937 about £6116 in cash and the residuary estates of the late Dr J. H Stothert and E. T. Browne as bequests. It is announced that the Pilgrim Trust has endowed funds for six years for two annual lectures one to be delivered in London by a Fellow of the National Academy of Sciences, Washington, and the other by a Fellow of the Royal Society in America, the object being to promote good relations between the two English-speaking nations. The first lecturer under this scheme is Dr Irving Langmuir of the General Electric Company, America.

In the Anniversary Dinner held on the 30th November the guest of honour, Sir Jhn Simon, in proposing the toast of the Royal Society, gave much valuable information about origin of the Royal Society. We learn that its beginnings were laid at a meeting of some enterprising men at the Wadham College, Oxford. Sir John described in picturesque language the three governing ideas of the Society.

It was some space after the end of the Civil Wars at Oxford, in Dr Wilkins his Lodgings, in Wadham College, which was *then* the place of resort for Vertuous and Learned Men, that the first meetings were made, which laid the foundation of all this that follow'd.

'Allow me, My Lords and Gentlemen, to remind you for a few moments of the remarkable character and achievements of Warden Wilkins. He preserved his position as the Head of the College both before and after the Restoration. He commemorated the Commonwealth by marrying a sister of Oliver Cromwell, but his latitudinarian views were found not to be displeasing to Charles II. He wrote a treatise to prove that the moon was habitable, and another one to discuss how

it would be possible to make the journey thither. He invented, and made considerable use of, a universal language. He wrote a learned work, as was appropriate to a future Bishop of Chester, to prove, from the dimensions given in Holy Writ, that Noah's Ark was big enough to contain all the animals on earth. Aubrey described him as "the principal reviver of the new philosophy at Oxford"—that is to say, natural philosophy pursued by methods of experimental science. And he had the extraordinary good fortune, when Head of this small College at Oxford, to have among his undergraduates a young gentleman named Christopher Wren—that universal genius who was mathematician, chemist, biologist and architect, all rolled into one. Associated with Wilkins, too, was that remarkable physicist the Honourable Mr Robert Boyle, whose portrait you see reproduced on the card of this Dinner.

'Let me read you a passage from Evelyn's *Diary*, under the date of 13 July 1654, which shows how solid and well-founded is the claim that it was within the walls of Wadham that this new learning was cultivated and pursued:

We all din'd at that most obliging and universally curious Dr Wilkin's at Wadham College. He was the first who shew'd me the transparent apiaries, which he had built like castles and palaces, and so ordere'd them one upon another as to take the honey without destroying the bees......He had also contriv'd an hollow statue, which gave a voice and utter'd words by a long conceal'd pipe that went to its mouth, whilst one speaks through it at a good distance. He had above in his lodgings and gallery variety of shadows, dyals, perspectives, and many other artificial, mathematical, and magical curiosities, a way-wiser, a thermometer, a monstrous magnet, conic and other sections, a ballance on a demi-circle, most of them of his owne and that prodigious young scholar, Mr Chr. Wren, who presented me with a piece of white marble, which he had stain'd with a lively red, very deepe, as beautiful as if it had been natural.

'In 1660 it was resolved at a meeting of twelve persons that Society should be formed "for promoting physico-mathematical experimental learning." That was in London, and the Society, of course, is the institution whose health I am proposing.

'So much for origins. And when one considers the achievements of this splendid institution, whose record now stretches continuously over two and three-quarter centuries, one may detect running through its work three governing ideas, which I venture to formulate to-night.

'First, your founders and those who came after them have held firmly by the doctrine that the business of the investigator is to pursue his experiment, wherever it may lead, without any regard to orthodox tradition.

'Secondly, from the very first down to to-day, this organized instrument for the pursuit of knowledge has been used by its members with no idea that scientific discovery would necessarily be of immediate practical utility, but because the truth is worth finding out for its own sake. And as a result, to a perfectly incredible degree, these new discoveries have in fact been found to contribute immensely to the benefit of mankind. Names such as Davy, Kelvin, Rayleigh and another name which stirs in us a poignant feeling to-night, the name of Rutherford—to mention merely these instances, have established that claim for the Royal Society for all time.

'And thirdly, the practice and precept of this Society embody the great principle that it is by the interchange of scientific ideas between scientific men of different kinds that progress is best achieved, notwithstanding the intense specialization of the age. I was interested to notice, in looking through Thomas Sprat's book, that he expressed this last view in these curious words:-

If I could fetch my materials whence I pleas'd to fashion the Idea of a Perfect Philosopher: he should not be all of one clime, but have the different excellencies of several Countries. First, he should have the Industry, Activity, and Inquisitive humour of the Dutch, French, Scotch, and English, in laying the ground Work, the heap of Experiments: And then he should have added the cold, and circumspect, and wary disposition of the Italians, and Spaniards, in meditating upon them, before he fully brings them into speculation. All this is scarce ever to be found in one single Man: seldom in the same Countrymen: It must then be supply'd, as well as it may, by a Public Council; wherein the various disposition of all these Nations, may be blended together. To this purpose, the Royal Society has made no scruple, to receive all inquisitive strangers of all Countries, into its number.

'Science has thus a special claim for the respect of those whose working life is largely concerned with public affairs. It is completely international; it speaks all languages and it knows no frontiers. It is capable of being an ambassador of peace and goodwill for the whole world.

'Literature -and I speak as a humble and devoted worshipper of the Muses—has often been the vehicle for national passions, and perhaps for national prejudices. Tennyson's *Maud* was published during the Crimean War,

and it cannot have been a contribution to peace to call the ruler of Russia "a giant liar" or to write the line: "And Jack on his ale-house bench has as many lies as a Czar."

'Art, too, has often been misused for purposes of national rivalry and ridicule. But the work of men of science in pursuing the truths of Nature is in its essence a contribution to the things which are capable of binding together the nations of the earth.

'The Royal Society has a fine record in this respect. I recall two incidents in the history of your Fellows. In the middle of the Napoleonic Wars Davy was awarded by the *Institut de France* a great prize of 3000 francs. There were those in both countries who criticized either the award or its recipient. But it was a fine gesture that, when these two countries were locked in the conflict of war, learned men on the one side of the Channel gave honour to a learned man on the other. Davy himself claimed that the influence of a man of scientific reputation "can soften the asperities of national hostility." The other incident to which I would refer occurred when the Peace of Amiens suddenly broke down. At that moment there were many Englishmen travelling on the continent of Europe. Some of them were arrested by the French authorities as alien enemies and detained as non-combatants within the confines of France. They applied for their release. One of these was Edward Jenner. When Napoleon examined the list, it was the finger of Josephine who pointed to the name of Jenner, and Napoleon declared: "We can refuse nothing to that man."

'Great then are the contributions in the public and international sphere which it is in the power of men of science to make. May their contribution be used for the benefit and advancement of mankind, and not abused to add to the destructive powers of the world. I wish all that is good to this splendid institution, the most famous and ancient of its kind, not only because I have been brought up to reverence learning and to respect knowledge, but because the work which you, Mr President, and your Fellows are doing is capable of spreading peace among the nations of the earth.'

The President of the Society, Sir William Bragg, in replying remarked:

'Sir John has spoken of the part which Science may play in drawing the nations together and so contributing to the peace of the world. The relations between knowledge and the unity of mankind are indeed most important. It is well to draw attention to them. Long ago the Greek philosophy held that knowledge and the exchange of knowledge differentiated the reason of man from that of the animals. The exchange was essential; success in the pursuit of knowledge was a social matter. A modern writer[1] has reviewed the question in the light of the events of the thousands of years that have elapsed since then. He has observed that there is a certain correspondence between the period of maximum scientific activity and maximum realization of unity. Thus the Greek construction of science and philosophy may be connected with the formation of the Greco-Roman world, at the head of which were men trained in Greek philosophy attempting to apply the rules of reason to an accumulation of sociological knowledge. Again, the revival of science in the fifteenth and sixteenth centuries is allied to the discovery of the New World and the expansion towards the West. And once more, towards the end of the eighteenth century the rapid increase of science led to a new linking up of the world eclipsing all that the earlier centuries had to show.

'The question, however, which most nearly concerns us is this: Does the increase of knowledge of Nature bring about that unity which makes for peace? No doubt it brings the nations together in the sense that they become more aware of each other, that their intercommunications have increased, and that they trade with each other more freely. But do jealousies and hatreds and causes of conflict disappear? I am afraid that history shows no such happy result. Was there ever a more quarrelsome set of little States than those that grouped themselves about Athens and Sparta? Did Europe settle down to peace when after the Renaissance experimental methods expanded the knowledge of the natural world? The eighteenth and nineteenth centuries were full of war in spite of their scientific activities. And worst of all, since the last great war, though natural knowledge has grown astonishingly, the present world is seething with unrest; both in Europe and in Asia bitter wars are in progress. The clouds overhead are dark and heavy.

'Yet I think that if we look at another part of the sky we can see rifts in the clouds; and the wind is blowing from that direction.

'Let me define the position as it appears from another point of view.

'Man, they say, has raised himself above the beasts by his success in making tools, which have given power to his hands, and opportunity for the development of their skill. Much later came the sharpening of his senses due to the construction of instruments of observation, and the consequences have been and are tremendous. First came the measuring instruments of the old astronomers and geometers on which Greek and Egyptian science was based. These gave accuracy in the comparison of angles and distances, and through astronomi-

[1] F. S. Marvin, *Studies in the History and Method of Science*, edited by Charles Singer.

cal observations a certain knowledge of the passage of time. From these the knowledge of the natural world derived its increase for more than fifteen hundred years.

'Then towards the end of the sixteenth century came the microscope and the telescope, the pendulum and the thermometer, and science leapt forward with powers vastly increased. The telescope set far back the bounds of the universe, and the microscope opened up a world of the very small hitherto beyond the powers of the unaided senses. The pendulum provided a convenient and accurate measurement of time and the thermometer an estimate of temperature which outclassed the natural capacities of touch and feeling. It is odd that the common use of single lenses for 300 years should never in all that time have led to the use of lenses in combination. Spectacles had been in use in Europe since 1300. There used to be a gravestone in a Florentine church which bore the quaint inscription: "Here lies Salvino d'Amarto degli Amarti of Florence, the inventor of spectacles. May God forgive him for his sins. He died Anno Domini 1317.'"[1] Bernard de Gordon, physician of Montpellier, in his *Lilium medicinae* (1305), mentions them in recommending his own eyewash which renders spectacles useless! In Holland, at about the end of the sixteenth century, Jansen invented the microscope, and shortly afterwards Lippershey was commissioned to make telescopes for military use.

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'But it was Galileo who first made revelation of the immense powers of the new instruments. Following him came a long list of scientific workers of the seventeenth and eighteenth centuries who used their sharpened and strengthened senses in the building of a new experimental science. Early in the nineteenth century electrical and magnetic instruments came rather to add new senses than to improve the old. In recent years the X-rays, radioactivity, the ionic valve, the cloud chamber and other new instruments have furnished yet further means of observing the world in which we live. As a result the boundaries of that which is observed by unaided eyes and ears and other senses have been far overpassed; our familiar world has become but a spot in the middle of an expanse whose horizon is constantly receding.

'Now it is to be observed that the knowledge of this wider world and of its contents is of vital importance to us. Our interest in it is not merely academic. We live in it and are part of it. We are, so to speak, citizens not only of the town in which we have lived without acquaintance with what lies outside the town walls, but citizens also of a wider country. We know that we must obey the municipal laws. We now find that there are country laws, of which we have had no knowledge hitherto, and these also must be obeyed under penalties which may be of the utmost severity. Indeed we have in the past suffered heavily because we have unwittingly broken them. If this seems to us unjust, it must be remembered that in our ignorance our judgment is of no value. Moreover the country of which we are now aware is full of resources, which we can gather according to our powers, and use according to our will.

'We are in a continuous state of adjustment to the conditions in which we find that we are living. We cannot shut ourselves within the town walls and refuse to look outside. We must step out into the open, and this is in effect what men are doing. The more they do so, the more they forget the divisions and quarrels of the town, the more the nations find that they must act together. Consider the various activities of mankind at the present time and see what is happening.

'To begin with, there are the activities of the search for knowledge, inspired simply by the wish to know and understand without thought of application of what is discovered. In this the nations act as one body. In every branch of science, knowledge is fully interchanged: men from all nations meet continually in conference and speak in one language though their vocabularies may differ. As knowledge grows, conference becomes more frequent and the feeling of comradeship grows also.

'There are the vast subjects of medicine, surgery, hygiene. Here also is the same search in common: the same collaboration between the men engaged in it. The governments of the nations are now deeply concerned. What government would not gladly communicate to any other a discovery which made for health? Indeed, the health of the world becomes a matter in which all nations must take counsel together, framing laws to govern such matters as the spread of infection, the provision of remedies, quarantine and so on. The health of the animal world in land and sea, of the vegetable world, pests and antipests, all that concerns the production of food and other necessaries of life grow more and more international the more account is taken of the new knowledge.

'The same is true of the trade of the world. In all the complicated arrangements that the nations in council must make for the conduct of traffic on the seas and in harbour, for lighting, direction finding and other aids to navigation, for charting, for the examination of goods in transit, for transportation on land, an in very many other matters, the new knowledge permeates the whole business. The nations are obliged to act together, and they do so.

[1] Loc. cit. p. 399.

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'Knowledge of the wider world has transformed the means of communication of intelligence, by mails travelling over land or sea or in the air, by telegraph and telephone, by wireless. The nations cannot use the new means unless they confer. Hence the many conferences, and the continued exchange of information, and the consultations of the directors of the various activities.

'The same is to be said of meteorology, a study which is based on observations of the modern kind, and is only possible when the whole world contributes to it in ways that are determined in a world council.

'Equally true is this of standards of weight and length and time, of illumination, of electrical and magnetic and many other quantities and qualities. Here again the various countries of the world must, and do, confer: and the information which they exchange is expressed in terms that the unaided senses cannot appreciate. So also the tests of materials that are used in the vast and varied constructions of the world must be determined by common action. In the spring of this year a great international conference assembled in London, at which these matters of world importance were discussed. It was notable that the discussions turned continually on observations belonging to the wider world of the aided senses, and it was the width and depth of the questions discussed that had brought the nationalities together.

'The point I would make is this, that modern science and modern applications of science are leading to a vast amount of international effort. The new knowledge of Nature is opening up activities of which man is eagerly making use: and the character of these activities is such that co operation between the nations is necessary to success. As a consequence co operation already exists, and is increasing. The old assertion is being fulfilled, that the progress of knowledge is a social affair, demanding co-operation and harmony. Knowledge of Nature in itself does not so much bring peace as the common pursuit of that knowledge.'

The *Notes* on the Foundation and History of the Royal Society will be of interest to those who have witnessed the National Academy Controversy in India.

We learn from this chapter that the Royal Society was one of the earliest practical fruits of the philosophical labours of Francis Bacon, who in his *New Atlantis* advocated the foundation of a Philosophers' College. On Sept. 22, 1641 there arrived in London, a celebrated Czechoslovakian Philosopher, Jan Amos Komensky, better known as Comenius on the invitation of Samuel Hartlib, an influential citizen of London, and a friend of Milton. Comenius, who had been a bishop, but was expelled on religious grounds, had written a book "*Pansophic Prodromus* (Essay towards complete wisdom) which made a great appeal to the earnest-minded men of the times and was translated in several European languages. Hartlib in inviting Comenius ended with the words "Come, come, come: it is for the Glory of God: deliberate no longer with flesh and blood." Comenius met in London a number of prominent English Leaders, Pym, Selden, Lord Brooke, and others.

During his residence in London, Comenius explained his plans in a tract entitled *Via Lucis* which he described as

'a reasonable disquisition how the intellectual light of souls, namely Wisdom, may now at length at the approach of the eventide of the world be happily diffused through all minds and peoples.'

He further wrote

'It is hardly necessary to describe how indispensable a School of Schools or Didactic College would be, in whatsoever part of the world it were founded: even if there be no hope for the actual establishment of such a college—corporations being left wherever they are, the design itself should be cherished with a holy faith among the learned, pledged as they are, to promote God's glory in this very matter. These men should make it the object of their combined labours to establish thoroughly the foundations of the sciences, to spread the light of wisdom throughout the human race with greater success than has heretofore been attained, and to benefit mankind by new and useful inventions. For unless we desire to remain ever in the same position, or even to go back, we must take care that our successful beginnings lead on to further advances. For this no individual, and no single generation sufficeth, and it is therefore essential that the work should be carried on by many persons, working in concert and using as a starting-point the researches of their predecessors. This Universal College would bear the same relation to other schools that the belly bears to the other members of the body, that of a living laboratory supplying sap, vitality, and strength to all.'

On commenting on Comenius' part, Dr F. Young M.A. (Oxford), corresponding member of the Royal Bohemian Society of Sciences, Prague writes

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'The visit of Comenius to London in 1641-2 marks an important stage in the development in this country of the idea of a great institution for scientific research, which resulted in the organisation of the "Invisible or Philosophical College" by Theodore Haak and others in 1645, and the foundation of the Royal Society in 1662.'

The Invisible College which was the immediate precussor of the Royal Society was however no Pansophic University, carrying out the dreams of Comenius

It was merely a club of young men, some of the intelligentsia of that day, brought together by common college backgrounds and many common interests for rest and refreshment from the political, theological and military turmoil of the times.' The Invisible College (the name was first used by Boyle) included a small group of friends—Wallis, Wilvins, Goddard Ent, Scarborough, Glisson, Merrit, Boyle, Foster and Haak—whose ages ranged from eighteen to forty eight. Theodore Haak, a Calvinist refugee, had joined with Hartilib in welcomeing Comenius to England in 1641: the other members of the group were none of them named by Comenius as his friends or patrons who were older men.

The history and constitution of election methods of fellows of the Society which proved to be a matter of some controversy, make a very interesting reading

Unlike the Academies of Science in most other countries where they exist, the Royal Society is not restricted by the terms its Charters in the number of candidates which may be admitted to the Fellowship. The selection and election of candidates is left to the absolute discretion of the President, Council and Fellows of the Society. The manner in which they have carried out this duty in the past is of special interest in studying the growth of the Society.

From its foundation the Society was absolutely dependent upon its own resources, for it had neither a subvention from the State nor were its publications printed by an official printing press, advantages which other national academies have usually enjoyed. The subscriptions of its Fellows and occasional gifts and bequests were all that the Council could look to for meeting the growing expenses of the young Society. The development of an adequate membership was therefore imperative, and long engaged the Council's attention.

The number of Fellows at the Anniversary 30 November 1663 was 131; this rose to 199 a few years later, and then fell off to 116 in 1691; by the end of the century there were 125 besides 37 foreign members. Admissions to the Fellowship during these years were on the average only nine in each year, and this was hardly enough to maintain the membership near its original figure, but with an average of twelve admissions in the decade 1701 10 and of eighteen in the next decade the membership began to rise. In these totals of membership and in those which follow the Royal Patron and Royal Fellows are not included.

About this time interest in the Society and its aims seems to have waned temporarily since in 1680, the attendance at the meetings was so meagre that the Society was in danger of being dissolved. Evelyn writes to Pepys begging him to attend the weekly meetings 'even if you cannot be there until 6 or 7 o'clock.'[1] Hooke, too, in his diary comments on several occasions on the meagre attendance. But things soon began to mend, and the election of Newton to the Presidency in 1703 may well have had considerable influence in bringing about the rise in the number of Fellows which occurred in the early part of the eighteenth century. The average number of candidates admitted to the Fellowship, which had hitherto been nine in each year, rose to fifteen for the twenty years 1701-20. For the remaining eighty years 1721-1800 the average was twenty three; the number varying from 19.9 in 1751-60 to 25.7 in 1771-80. Consequently the number of Ordinary Fellows rose steadily from 121 in 1697 to 195 in 1721, 303 in 1741, 352 in 1761, 479 in 1781, reaching 545 in 1801.

Foreign members, who numbered 24 in 1697 and 37 in 1701, continued to increase in number as though the qualifications of such candidates were not scrutinized closely enough by the Council. By 1721 their number had risen to 64, and by 1766 to 170, or about half as many as the Ordinary Fellows of the Society in that year. By 1761 the Council felt that the Foreign Members, who then numbered 154, were becoming too numerous, and enacted a Statute providing that their certificates should be signed by at least three 'Foreign Fellows' as well as 'by three Fellows named in the Home List.' In 1765 Council further resolved that no Foreigner be proposed for election who is not known to the learned world by some publication or invention which may enable the Society to form a judgment of his merit; also that until the number of Foreign Members be reduced to eighty not more than two be admitted in one year. In the Statutes of 1776 the restriction of two elections a year is omitted, and ten years later the number of Foreign Members was limited to 100, which was altered to 50 in 1823. The result of this was that the number of Foreign Members in 1801 was 77 only, or about one-seventh of the number of the Ordinary Fellows of that year.

[1] Pepys, vol. ii, p. 337, by A Bryant.

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At the outset scientific men had only constituted about one-fifth of the membership of the Society, the rest of the Fellows being drawn from the educated classes of the time and not necessarily from any of the learned professions. This continued to be the constant practice of the Society for many years so that its membership consisted, firstly, of men of science, and secondly, of those who from their position in society or their fortunes it might be desirable to include as patrons of science. The proportion of these two classes varied from time to time but it was not until the middle of the nineteenth century that the general principle was revised.

As the Society became more firmly established and better known, candidates for election became more numerous. Throughout the whole of the eighteenth century there was a steady rise in the number of Fellows, which reached 545 in 1801; it continued to increase year by year until 1848. There is no means of analysing the membership at any point in the eighteenth century in order to determine what proportion of the Fellows were men of scientific standing, but the ready admission of others, most of whom apparently paid a composition fee of £40 instead of an annual subscription, suggests that those who were elected not for their scientific eminence alone were in the majority. To quote a single case: Sir Roderick Murchison, the geologist, was elected a Fellow of the Royal Society in the spring of 1826; for this honour, as the President, his old friend Sir Humphrey Davy, told him, he was indebted not to the amount or value of his scientific work, but to the fact that he was an independent gentleman having a taste for science, and with plenty of time and enough means to gratify it.[1]

Numerous pamphlets and other publications criticizing the administration of the Society appeared during the early part of the nineteenth century and from one of these the proportion of scientific Fellows to the rest can be deduced since the author gives an analysis of the communications from Fellows which were published in the *Philosophical Transactions*. Of the 662 Fellows who formed the Society in 1830 only 106 had contributed at least one communication which had been published in the *Philosophical Transactions;* and of this number 44 of them had contributed only a single paper.[2] The great majority of the Fellows, therefore, were doing very little to promote the advancement of Natural Knowledge.

[1] *A Memoir of Sir Roderick Murchison*, by A. Geikie.

[2] *The Royal Society in the Nineteenth Century*, by A. B. Granville, F.R.S., London, 1836, pp. 33—39.

This problem had long been before the Council and as early as 1674 ' the ejection of all useless Fellows ' had been proposed by Newton, but this raised too many difficulties. Many discussions, both in the Council and informally among the Fellows themselves, took place as time went on, and in 1831 the Council appointed a Committee to re-examine the whole question. The Committee reported that any alterations in the Charters would be difficult and expensive to carry out; and for this reason they recommended a revision of the Statutes by which six signatures of Fellows instead of three on the certificate of each candidate should be required; also that elections should take place only at the first ordinary meeting in December, February, April and June, instead of at any meeting. These remedies proved quite ineffectual; by 1834 it was found that four meetings did not suffice for carrying out the election of the candidates under the procedure then in use, and therefore this restriction was dropped. No reduction in the number of candidates had been effected, for the records show that 50 were elected in 1834; nor does it appear that any critical selection of those who were the most suitable for their scientific knowledge had been introduced. Moreover, during the forty years 1801 to 1840 the elections numbered 1081 while the deaths were only 776, so that the membership was still increasing steadily.

It may well be that the large number of Fellows who compounded for their subsriptions presented a financial problem of some difficulty. In 1847 there were 480 who had compounded as compared with 284 who were paying an annual subscription; and there is good reason to suppose that non-scientific Fellows formed the great majority of those who had compounded. If the average annual number elected was to be reduced from 27 as it then was, to 15 as had been suggested in 1846 and as was actually done in the following year, the Society's annual income might suffer to the extent of twelve composition fees of £40 each. This may well have caused Council to hesitate before taking such a step. In 1831 the Treasurer's report was printed and published in full for the first time, and in it we see that the receipts from composition fees from 27 out of 29 newly elected Fellows brought in £1080, while subscriptions for the year amounted to only £286.

In May 1846, in consequence of a proposal made by W. R. Grove, F.R.S., another Committee was appointed by the Council to examine and report upon the Charters and Statutes; they held several meetings and presented their report to the Council on 16 June 1846, together with a draft of new Statutes which included certain alterations proposed by the Committee. This report was considered by the Council at several meetings and was finally adopted on 10 February 1847 when orders

were given to print and circulate to the Fellows the revised Statutes. The two most important provisions were (i.) that the election of candidates for the Fellowship should take place once a year only, and (ii.) that the Council should select not more than fifteen candidates whom they cosidered suitable and should recommend them to the Society for election. During the discussions in Council amendments to replace the number 15 by 17, or by 20, were proposed, but the original number 15 was finally adopted. The effect of this was at once apparent; the admissions for the years 1841-47 had amounted in all to 176, or 25 yearly on the average; in 1848 and in the subsequent years up to 1930, 15 only were elected.

The Statute which, with two alterations made in recent years, has been in force until now, in no way alters the right of the Fellows, which is conferred on them by the Charter, to elect whomever they may please and as many as they please at a general meeting of the Society.

For the twelve months 1 December 1846 to 30 November 1847, the Membership of the Society included: Patron and Royal Fellows 13, Foreign Members 47, Ordinary Fellows who had compounded 480, Ordinary Fellows paying an annual subscription 284, so that the total number of Ordinary Fellows was 764. Numbers now began to fall steadily; in the twenty years 1848-68 the number of Ordinary Fellows had fallen by 218, and in the next twenty years, 1868-88, by 77, bringing the number of Ordinary Fellows to 469 in 1888.

It is instructive to note that this large reduction affected the list of compounding Fellows almost exclusively; while in 1847 those who had compounded numbered 480 and the annual subscribers 284 only, the corresponding numbers in 1868 were 289 and 257, and in 1888 they were 182 and 287. The total number of Ordinary Fellows has since then not varied greatly, but the annual subscribers have increased by about 120 at the expense of those who preferred to pay the composition fee which was at first £40, then £60, and is now £75.

This restriction on the number of candidates to be admitted annually to the Fellowship, and the demand for adequate scientific qualifications which was the natural consequence of it, constituted the most important change in the administration of the Society which had been made since its foundation. It changed it at one stroke from being an eminent body of cultivated men only a proportion of whom were devoting their lives to the advancement of Natural Knowledge to one in which the promotion of science was the first aim, and for admission to which a certain standard of scientific eminence was obligatory.

In 1875 a Committee was appointed by Council to consider 'whether it is desirable or not to make any alterations in the Statute relating to he Election of Fellows.'

They recommended that the duty of selecting the candidates should be left in the hands of the Council, and that the number to be selected and recommended annually to the Society for election should continue to be fifteen.

Since then, the number of candidates to be recommended for election in each year has been altered twice; it was raised to 17 in 1930 and to 20 in 1937, at which figure it now stands.

The membership on 30 November 1937 was made up of:

Patron and Royal Fellows	4
Foreign Members	50
Fellows	453

The number of Ordinary Fellows has only varied between 442 and 459 during the last fifteen years. It is of interest in this connexion to note that in the early years of the nineteenth century Dr W. H. Wollaston expressed the opinion that about 400 would be a suitable number for the fellowship.

The experience of England in organising her National Academy of Sciences (for the Royal Society of London is recognised as such by the British Government, in spite of the existence of other Royal Societies, Academies, and Societies devoted to particular subjects in the United Kingdom) will be invaluable to those in India who are now trying to organise the senior scientific men of India into a national body, capable of weilding suffeicent influence amongst scientists as well as with the Governments.

Review of the Rockefeller Foundation for 1937

We have for some time past with us a booklet titled *The Rockefeller Foundation—A review for the year 1937*, by Raymond B. Fosdick, President of the foundation. It will be remembered that the late J. D. Rockefeller, who died at the age of ninety-eight on May 23, 1937, made gifts for philanthrophic purposes to the staggering amount of 530 million dollars, *i.e.*, nearly 160 crores of rupees in Indian money. The yearly income would appear to be nearly 7 crores of rupees, exceeding the total budget of the province of Bihar. The ways and means by which J. D. Rockefeller made his money were not, according to some critics, always clean and above board. The curious reader may turn to the lucid account given by H. G. Wells in his *Wealth and happiness of Mankind*. But if money was ever well-spent, here is the case!

It is estimated that since their foundation, the various Rockefeller foundations have spent nearly 665 million dollars, *i.e.* nearly 200 crores of rupees, for philanthropic purposes.

There ought to be a sound philosophy, and method behind all manner of charities, otherwise these may be entirely futile, as so many of them are in India. Infact, the late Mr Carnegie, whose charities came next to that of Rockefeller (400 million dollars), used to say ' It is more difficult to spend money than to earn,' and consistent to this maxim, he devoted the last twenty years of his life to the administration of the funds created by him, as the constitutional head. Let us therefore see what the philosophy behind the Rockefeller charities was and how the funds have been administered. We learn from the report

Mr. Rockfeller always made his gifts after thorough study and careful planning; and its is perhaps appropriate at this time to mention one or two principles which guided him. These principles were not necessarily formulated at the beginning of his career; rather they were the result of his long experience in philanthropic activity.

In the first place, he trusted the future. He did not think that benevolence and wisdom were confined to his generation. He was not under the illusion that what seems important to-day will necessarily be important to-morrow. He did not believe in tying up foundations to rigid and unchangeable purposes. He was familiar with English as well as with American experience in the creation of trust funds, and he would have agreed with Sir Arthur Hobhouse in the latter's comment on medieval foundations that "a nation cannot endure for long the spectacle of large masses of property settled to unalterable uses."

The wisdom of the last passage is illustrated in the futility of those charities which were after temple and monastery foundations, and no country suffers so much from the evil effects of these as India, which has a large amount of property, or is supporting bands of men who are not, to say the least, useful to society. In Europe, such foundations have been dissolved by State decrees or by some other drastic method. Witness the closing of monasteries in England by Henry VIII and Cardinal Wolsey. But who is going to do that in India?

The sole purpose of the Rockefeller Foundation is stated in its Charter to be

" to promote the welfare of mankind throughout the world."

If any restriction was laid, this was removed by Mr Rockefeller writing to the Trustees of the general Education Board in 1920.

" If in any gifts heretofore made to you by me there are any restrictions or limitations as to the specific purpose for which they are to be used, I hereby revoke such restrictions."

No Perpetual Endowment

The Endowments are not perpetual, because Rockefeller did not believe in perpetuity. " Perpetuity is a pretty long time," he used to say. All the Rockefeller Trusts are allowed to spend the income as well as the capital.

In fact, some of the trusts were liquidated, or amalgamated with general funds after it was found

that the motive for which these trusts were created no longer existed.

"Do not legislate for infinity."

This idea of Mr Rockefeller's has had great influence in shaping the policies of the boards which he established. The temptation to visualize the future in terms of the present —to think of the needs and methods of to-day as having a sure claim to immortality—is one which confronts trustees as well as founders of philanthropic foundations. For example, to establish under a permanent endowment in some university or research centre a department or chair of psychiatry or organic chemistry may seem, with such light as we have at the moment, a rational and socially desirable step. But what wisdom have we to-day to determine that a century or more hence psychiatry and organic chemistry will represent the pressing needs or the practicable techniques of that time? In endowing what they thought was of permanent importance, earlier generations made wrong guesses which embarrass us to-day. How can we assume that our guesses have any greater validity or are made with any clearer foresight?

This principle gave wide latitude to the Trustees of the Fund in the expenditure of the income as well as the capital. The general policy is laid down in the following notifications

(1) Ten years after the date of the gift, the income from it may be used in whole or in part for some purpose other than that for which the gift was made, such purpose to be as reasonably related to the original purpose as may be found practicable at the time, having regard to intervening changing conditions.

(2) Beginning five years after the date of the gift, 5 per cent of the principal of the fund may be used each year for any purpose for which income may then be used.

(3) After the expiration of twenty-five years, any part or the whole of the principal may be used for some other purpose, the new purpose as in point one to be as reasonably related to the original purpose as may be found practicable at the time, having regard to intervening changing conditions.

A full account is given of the total amount spent in 1937. This amounted to the huge total of nearly 10 million dollars, nearly three crores of rupees, besides recurring expenditures. The amount spent was distributed over 88 countries from Norway to Peru, the major part, of course going to the United States, and for medical and biological purposes. In fact, for some time past, it has been the policy of the Rockefeller Foundation to patronize medicine and biology to the exclusion of Chemical and Physical Sciences, so that the votaries of these latter subjects must find out some biological theme if they wish to get money from Rockefeller for their researches. We, for our part, do not consider that this is a sound policy.

Besides the U.S.A, the largest beneficiary has been China (nearly half a million dollars) where the Foundation gives grants to universities, medical colleges, for research and development. Rockefellers have a soft corner for China in their heart. In the review for 1936, the following sentence appeared:

"China to-day stands on the threshold of a renaissance. The Chinese National Government, together with many provincial and county authorities and private organisations, are attempting to make over a medieval society in terms of modern knowledge."

This proud ambition, in which the Foundation was participating, has been virtually destroyed by the events of the last six months. The programme was primarily a programme of rural reconstruction and public health. It was rooted in promising Chinese institutions like Nankai University and the National Agricultural Research Bureau, both in Nanking. It was promoting studies in subjects like animal husbandry and agriculture; it was carrying on broadly based field experimentations; and it was training men and women for administrative posts in rural and public health work.

Nankai University was completely destroyed last July. The universities and institutions in Nanking, where they are not too badly damaged, are serving to-day as army barracks. The field units in mass education and public health are so completely scattered that it is practically impossible to locate them. The work, the devotion, the resources, the strategic plans of Chinese leaders for a better China, have disappeared in an almost unprecedented cataclysm of violence.

At the moment there is nothing further to report. The Foundation still maintains its office in Shanghai. Whether

there will be an opportunity to pick up the pieces of this broken programme at some later date, no one can foretell.

We express our genuine sympathy with China which as far as industry and science are concerned, is in very much same condition as India. We regret very much that the sincere attempts of the Chinese leaders at a Renaissance should be so rudely disturbed by the aggressive action of a neighbouring imperialist power. We can only hope that out of her present struggle will emerge a new and reborn China which will again carry forward the torch of a higher civilization. It may not be out of the way to mention here that medieval China gave to the world the three great discoveries which made modern Europe great. These discoveries are: paper and printing machine, magnetic compass, and gunpowder, but alas! China herself never made any largescale use of these. The Academy Sinica, and other Chinese Scientific Institutions, which were doing splendid scientific work now lie in ruins, as a result of the sanguinary conflict and still we call the modern age "An enlightened one!" Contrast with this the work of Kublai Khan, grandson of Chenghiz Khan, who conquered China in 1265, and instead of razing the monuments of previous times to the ground to celebrate his victory, raised China by his wise administration to a pitch of prosperity which it had not since witnessed (*vide* pages of Marco Polo). Who were the greater barbarian, the nomad Mongol, or the enlightened modern nations who carry forward civilization with howitzers, poison gas, and aeroplane's dropping bombs, and in times of peace with tariff barriers and discriminating legislations!

Rockefeller's Charities do not extend to India

Almost every European nation has been the recipient of Rockefeller Charities, even such ones as are piling up armaments for offence and defence, France for the University of Paris (The grateful French adorned J. D. Rockfeller Jun. with a Legion d'honnour), Germany for the Physics Department of the Kaiser Wilhelm Institute; England for her Medical Research Council, and Library of the University of Cambridge. Italy has been left out -- the Abyssinian venture gave her too bad a name. We have grave doubts whether the Spirit of the Donor looks with approval upon such large endowments to countries which have surplus enough to manufacture armaments for the destruction of mankind. However, it is for the present administrators of the Foundation to satisfy their conscience. To us, The policy appears to illustrate, apart from anything else, the wellknown adage of "Carrying coal to New castle." The endowments will be justified if the recipients are men who are carrying on useful work, but probably, owing to their views, may not be in favour with their respective Governments.

In the long and impressive list of the endowments we are sorry to note that "*India occurs nowhere.*" We may be permitted to observe in this connection that neglect of India does not appear to be consistent with the motto of the foundation "*to promote the well-being of mankind throughout the world,*" when onefifth of the human race -inheritors of the most ancient civilization of the world—are left out altogether from the operation of the Great Charity especially when considerable scientific investigation is being carried on in this country under very discouraging circumstances. So far as India is concerned, the Rockefeller Foundation gave money for the construction of the All-India Institute of Hygiene at Calcutta, and have given a number of foreign scholarships to Indian graduates. But these grants are quite insignificant compared to those given to much smaller countries.

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Mount Kanobili Observatory

We have received two numbers of the *Bulletin* of the Abastumani Astrophysical observatory, Mount Kanobili, Georgia, U.S.S.R, of which E.K. Kharadse is the director. The observatory is situated in 41°.53′ North Latitude, 42° 45′ East Longitude from Greenwich, at a height of 1500^{m} above the sea level. It is a well-known mountain resort in the Caucasus, well known for its climatotherapeutic properties. The mean temperature varies between −5°C in January, to 17·5°C in July, the maximum rising to 31·5°C in July, and the minimum going down to −19°C in January. The cloudiness amounts to 51% in the year. The number of absolutely clear nights is 90, and partially clear nights 182. The transparency of the air is stated to be ·88 on the Pickering scale. These figures are the averages for 35 years. The site was chosen as the result of a scientific expedition sent by the Moscow Government in 1932. By the twentieth anniversary of the October Revolution (1937), the observatory became ready for work. It contains at present a 16-inch refractor, a 13-inch reflector, spectro-helioscope, auxilliary mechanisms, and a power-house. The instruments were all manufactured at the Leningrad Optical Institute. The observatory is maintained by the Government, and has five scientific workers, besides the director, and other staff.

Within the short period of its existence the observatory has turned out a large amount of astrophysical work, which is published in the two numbers of bulletins. The publication is in Georgian, Russian and English, and obstracts are sometimes given in English.

Though compared to the Great American observatories, the Mount Kanobili Observatory has started with modest equipments, we hope that it will develop into a great institution and will have many years of useful work before it.

Findings of the Bombay Advisory Committee on Education

The findings of the Committee appointed to advise the Government of Bombay on the question of vocational training for boys and girls in primary and secondary schools which made a survey of the present position of education in the Province can be summarized as follows:

"Over two-thirds of the population of the province live on agriculture. Our primary schools which are to cater mostly for the children in the rural area (*i.e.* for children of agriculturists and artisans who form the main bulk of the population) fail to appeal to an average villager. The reason is not far to seek. The village child is made to sit still for long periods at a time in the school room. The result of several years' schooling of this kind often is that the child grows into a weakling that is unable to stand the sun and the rain and is thus not of much use for hard work in the field. What little book-knowledge the child acquires does not appeal to a vast majority of the villagers, who, though generally illiterate, possess a strong common sense. Brought up on books and nothing but books, the village child looks down upon manual work. Conditions in urban areas are much the same."

What is needed is reorientation of educational ideals. Education must be made thoroughly practical, both in the primary as well as secondary stages, with a view to bringing our schools into intimate touch with the life, needs and traditions of the people.

This Committee was called upon to consider two important Reports on Education, whose authors give helpful suggestions as to how education could be made more realistic and practical. Messrs. Abbott and Wood have shown how it is possible to provide diverse courses

on definite practical lines at the secondary stage. This Committee have duly considered the proposals of these two specialists while making recommendations for diversified courses at the secondary stage. The Zakir Hussain Committee present a comprehensive scheme of primary education through suitable form of productive work.

After careful consideration, the Committee come to the conclusion that the principle of 'educating children through purposeful creative activities leading on to productive work' is sound; its adoption is best calculated to remedy the main weaknesses obtaining in the present system of education.

The Committee stress the fact that education to-day suffers from an excessive amount of book-work. The child sits couped up in the class room from day to day and from year to year, conning his books and filling his notebooks, reading, writing, reciting, listening to the monotonous drone of the teacher's voice, and having his head crammed with as many scraps of knowledge as possible. Instruction within the class-room is altogether divorced from the world without, and the child remains out of touch with the practical realities of life, the shadows of which he so assiduously or listlessly pursues in his books. The dull monotony of desk-work seldom rouses the living interest or the intellectual curiosity of the child. Sedentary work, continued over a long period of time, has a disastrous effect on his physique, and passive absorption of knowledge, needing little active effort on his part, kills all originality and spontaneity and cripples him, mind and soul.

"To remedy this state of affairs, the Zakir Hussain Committee's recommendation is that some " Basic craft " be selected around which all school work could be centred. This would be possible to some extent with " crafts " that are really " basic," broad and fundamental, " rich in educational possibilities " and touching the life of the child and the community at all points.

" We are of opinion that among others the following should be chosen as basic crafts in the reorganized primary schools:—

Rural and Urban.

(1) Agriculture including subsidiary occupations—Rural Area.
(2) Fruit and Vegetable Gardening.
(3) Spinning and Weaving.
(4) Wood-Work.
(5) Clay-Work.
(6) Home-Craft.

" We are of opinion that at the primary stage not more than half the school-day should ordinarily be devoted to formal instruction in the class room."

The Committee make numerous other recommendations regarding primary and secondary education and allied matters. These may be briefly summarised as follows:—

The Cimmittee consider that Central Schools should essentially be schools of general education. They should be labelled neither vocational nor pre-vocational.

The articles that are produced by School Children under the new Scheme of education should have as far as possible useable and/or marketable value.

In view of the fact that Hindusthani is fast becoming the national language of India, it is desirable that people in the non-Hindusthani Provinces should have a working knowledge of every-day spoken Hindusthani. Suitable provision should be made for the teaching of Hindusthani in the upper primary standards.

Special impetus should be given to the spread of education among girls and that in every scheme of compulsory education preference should be given to girls.

In view of the present schools being examination-ridden, external examinations should be abolished. Heads of Schools should hold their own examinations and make promotions after taking into account the record of the pupil's attendance, work in the class-room, farm and workshop and in general extra school activities, as also his performance in school examinations.

Provision should be made at suitable centres for continuation courses for the benefit of children who may leave school before completing the full primary course.

Early provision should be made for more training institutions and for an increase in the number of places in the existing women's training institutions with a view to securing more trained women teachers for lower classes of primary schools.

For the success of the scheme of Basic Education, it is essential that provision for a four years' normal

course (on a par with the Secondary School Course) for the training of teachers of basic schools should be made and that at least one such normal school should be maintained for each district.

Special training institutions for the training of teachers of Central Schools and Supervisors should be organised in all Educational Divisions and arrangements should be made in these institutions for vacation or refresher courses for teeahers already in service and also for the systematic use of the Cinema, Radio, Museums, etc., as definite aids to work in schools.

Supervisors of Primary Schools should be specially trained for their work and that each such supervisor should ordinarily be in charge of about 50-60 schools with headquarters near about the centre of his beat.

Secondary Education

As regards the problem of Secondary Education the Committee suggest that the Secondary School Course should begin at the end of the seven years' course of Primary Education.

Managements of High Schools wishing to maintain Standards V to VII of the Primary Course should be encouraged to maintain classes for the full seven years' primary course.

The duration of the Secondary School Course should be four years, the Standards being numbered VIII, IX, X, XI in continuation of the Primary Standards I VII.

It is proposed that the Secondary School Course should be divided into two groups: (1) General; and (2) Science.

The four years' course should be divided into two stages:—(1) Standards VIII and IX; and (2) Standards X and XI.

For standards VIII and IX, the course should be common to all, with the exception of practical work.

Further a special committee should be constituted to draw up detailed syllabuses.

To start with, teachers of requisite qualifications for Vocational work should be selected so far as possible from among teachers who have worked or are working in Vocational Institutions of good standing and established reputation, in consultation with a Board of experts.

In Secondary Schools the mother-tongue should be the medium of instruction in all subjects except English and Hindusthani.

The Committee think that English should not ordinarily be introduced before the first year of the Secondary School Course, *i.e.,* before the commencement of the work of Standard VIII. If in any locality, there is an effective demand for the teaching of English in the higher primary stage and if thoroughly satisfactory arrangements by the appointment of a qualified teacher or teachers for instruction could be made, instruction in the language may be permitted as an optional subject from that stage without any financial obligations on Government.

The aim of teaching English should be essentially practical. Since the whole system of Secondary Education is examination-ridden, the Committee recommend that with a view to removing the tyranny of the Matriculation Examination, Heads of Secondary Schools should be permitted to hold their own examinations and issue Secondary School Leaving Certificates on the basis of full four years' record of pupils' work in the class-room, on the play-field, in the workshop, in the social and general activities of the school, as also his performance in the school examinations.

The University be moved to have the present Matriculation Examination replaced by special tests or examinations for entrance to Colleges affiliated to the University with a view to securing right type of students for University courses, none but those holding the requisite Secondary School Leaving Certificates being considered eligible for admission to the entrance tests of Colleges.

Till such time as the University decides to abolish the Matriculation Examination, it should be moved to take steps to improve the Matriculation Examination by providing alternative courses of studies and by modernising the Examination generally.

English-teaching Schools that are permitted to teach English from the initial stage (as the mother-tongue of the pupil is not one of the recognized languages of the Province) may continue to do so as at present provided that the schools arrange for regular instruction in one of the recognised languages of the Province and/or in Hindusthani.

The Department of Education should arrange for the periodical inspection of Vocational work in Secondary Schools in consultation with a Board of Experts.

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General

The Committee recommend that the curricula sanctioned by Government should be regarded as standard in which alterations or modifications not inconsistent with the principles and spirit of the sanctioned Course may be made to suit local or special conditions after intimation in writing to the Department of Education before the commencement of the school year.

An Advisory Board of Education composed of official experts in the different branches of education and non-officials eminent in educational, vocational, business, or social activities, should be constituted. Its function should be:—

(1) To advise Government on matters of educational policy and practice.

(2) To collect information about educational activities and experiments in other parts of India as also in foreign countries.

(3) To issue bulletins disseminating modern ideas in education.

(4) To suggest ways and means for securing the co-operation of State utility services as also of commercial and industrial firms, particularly in the matter of pre-vocational training.

(5) To suggest arrangements for vocational guidance to pupils in Secondary Schools.

The Advisory Board should appoint sub committees for (1) general education and (2) pre vocational training with powers to co-opt experts.

The Committee are convinced that for the success of the new scheme it is essential that a Special Publication Bureau should be constituted for the preparation of books and appliances for the use of teachers as also for village libraries, school children and literate adults.

The emoluments of teachers in primary and secondary schools should be in accordance with the standard scales of pay that may be laid down for other public servants of similar attainments and responsibilities.

The scale of grants to aided schools should be revised to enable them to employ qualified teachers on adequate scales of pay with reasonable fixity of tenure and provision for old age and also to enable them to meet the extra cost involved by the provision of practical work in primary and secondary schools.

The Committee stress the need of libraries specially meant for the benefit of children who cannot continue their school course beyond Standard IV and suggest that Government should publish pamphlets giving information about careers for pupils and also about the preliminary education needed for such careers.

Part-time classes for continuation or vocational education of those who cannot avail themselves of education in day or full-time schools should be organised as suggested in the Abbott-Wood Report, wherever there is a demand for them.

In view of the fact that this Committee has put forward a Scheme of Primary and Secondary Education with substantial practical instruction, it is essential to provide an adequate number of specialised vocational, industrial, trade and technical institutions. Government should take steps for the establishment of such institutions.

Transitional Arrangements

The Committee suggest measures for transitional arrangements and propose that a Special Officer not lower in rank than a Divisional Educational Inspector be appointed immediately to organise all work in connection with the initiation and development of the scheme of Basic Education, that he should act in consultation with a small Advisory Committee specially constituted for the purpose and that he be given the help of necessary assistants.

Compact areas providing necessary facilities be selected in each district to try the experiment of " Basic Education ". So far as possible, all schools in such areas should be transformed into schools of the new type, the full Primary Schools within the areas being organised as Central Schools, *i.e.*, schools teaching the full seven years' basic course with arrangements for instruction in two or more productive crafts.

The above experiment be tried in the first instance during 1938-39, that if the results are assuring enough to scope of the experiment be extended during 1939-40, that the position be reviewed fully before the end of 1939-40 and that in the light of experience gained, arrangements for the complete reorganisation of Primary Education be made within five years.

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The Committee are convinced that for the success of the Scheme of Basic Education it is essential that immediate arrangements for the special training of select trained teachers preferably with aptitude for productive or manual work of some kind should be made separately for each Educational Division. The emergency course of training at the start should be of about six months and the instruction should include among other things—

(1) Training in at least two basic crafts.

(2) Formulation and working of simple projects and schemes of correlated studies.

(3) Inculcation of idealogy of education through productive work, *viz.*, method of learning by doing, relating education to actual life, scope of initiative, sense of social responsibility, spirit of social service for national co-operative community.

(4) A Special Course in Physical Training, Drawing and Music.

(5) A short course in Physiology, Hygiene, Sanitation, Dietetics, Social studies and Hindusthani.

(6) Teaching of at least 25 lessons in the practising school under proper supervision.

These training schools should be residential institutions where the individual teachers under training have opportunities of receiving training to live a vigorous social life in an atmosphere of perfect co-operation.

Finally it is suggested that the supervisors for the experimental schools should be select men and women who should be specially trained to enable them to supervise and guide the work in the reorganised schools in their charge.

1851 Exhibition Scholarships

It is well known that India has been sadly neglected in her claims for the award of scholarships to her deserving sons. We have several times commented on this in these columns, and the matter has also received considerable attention from other sources. Recently the Registrar of the Lucknow University referred to it in a letter addressed to the Secretary to the Government of India, Department of Education, in which he asked him to represent to the Secretary of State for India, on behalf of the Indian Universities, "that the funds at the disposal of the Commissioners for the Exhibition of 1851, be in future allotted more equitably to India, in promoting the knowledge of science and art and their applications in productive industry, in extension of their accepted policy applied to other parts of the Empire.

The letter goes on to say—

"It is understood that after winding up the affairs of the Great Exhibition of 1851, the Commissioners were left with surplus funds from which a great educational centre has been built up at South Kensington. The Commissioners still possess an estate of the value of £500,000 and an available income of over £20,000 per annum.

"On an average they have awarded about 17 scholarships annually, each scholarship being of the value of £150/- p.a. The Universities of Great Britain, Canada, Australia, New Zealand and South Africa were invited to recommend candidates for these scholarships, but Indian Universities were left out of consideration.

"Since 1922 the Commissioners have awarded 5 senior studentships of the value of £450-500 each p.a. for which the British Universities and educational institutions are invited to make recommendations. There are 8 Dominion scholarships of the value of £280-300 p.a. for which the Universities in the Dominions are invited to make recommendations. Further, three scholarships are alloted to Australia, two to Canada, one to South Africa and one to the Irish Free State (since 1923). From all these privileges India was excluded.

"Will you be so good as to urge upon the Commissioners the desirability and necessity of fair treatment to Indian Universties, or the ground that the contribution of India towards the funds of the Exhibition was very substantial indeed, as the accounts of the Exhibition will disclose.The Commissioners in their 9th report in 1935 state that "it is probable that any additional funds placed at our disposal could more advantageously be applied in extending the scope of the overseas scheme to include the more recently developed countries of the empire, and in particular India, where the growth of University education, within recent years, has been most rapid." Even the Commissioners admit that India has been neglected. It is for us to press for equitable treatment being extended to capable research workers from India.

"His Majesty's Government have recently released the Commissioners from an obligation of £65,000 towards the cost of the Science Museum, the interest on

this sum alone amounts to £2,000 p.a. This amount will cover the cost of two scolarships of the value of £250-300 p.a., tenable for two to three years. Recently one such scholarship has been offered to India since 1937. This is entirely inadequate from the point of view of our contributions to the funds of the Exhibition, as also from the point of view of innumerable research workers, for whom additional facilities abroad will be greatly beneficial, and whose contribution to the national wealth of India is expected to be of great value.

The letter clearly states the facts leading to the establishment of the scholarships (also vide Sc. & Cul., *1*, 480-82, 1936), and makes a strong case for the need of an equitable award of Exhibition scholarships to deserving Indians, and justice being done to this country.

Hydro-Electricity in Hyderabad States

Of the progressive Indian States though Hyderabad (Deccan) occupies a very high place, it has not paid attention to the possibilities of power development to to the extent as that of Mysore. Now the State has investigated its hydro-electric possibilities and the extent of electric power that can be developed from the two rivers namely the Godavari and the Kistna, which flow through the state has been ascertained to be about 145,000 K.W. continuous and there are possibilities of generating another 70,000 K.W., from their tributaries. Three projects have been put forward but the one of immediate importance is the construction of a joint reservoir at Mallapuram across the Tungabhadra river which would be capable of developing 42,000 H.P. The power generated would serve a nitrogen fixation plant, metal industries and rural electrification.

A comprehensive scheme has been worked out in which hydro-electric and irrigation projects are combined and the state would have a complete grid system. The total cost of all the projects for the development of the power possibilities would be about 65 crores and the capital expenditure would be spread over half a century and the scheme anticipates an estimated average return of about 8%.

Visit of Sir Leonard de Woolley to India

A press *communique* from Simla says that Sir Leonard de Woolley, the eminent British archaeologist has been invited by the Government of India to visit India in October and give the benefit of his experience in the work of archaeological excavations to the Government of India. The *Communique* says:—

" Extensive excavations, carried out by the Archaeological Survey of India at Mohenjodaro, Harappa and other places, have revealed the existence in these regions of a widespread ancient civilization similar in many respects to the Sumerian civilization of the Near East with which it had established contacts. In order to provide for fruitful co-operation in this particular field of exploration between the archaeologists in India and the archaeologists working in the Near East, it appeared desirable to the Government of India that the Archaeological Survey of India should have the benefit of the services of some eminent archaeologist who had worked on the Sumerian exploration in Iraq and other countries in the Near East. They have, accordingly, invited Sir Leonard Woolley to spend the next winter in India.

" Sir Leonard, who has accepted the invitation, will arrive in India by the end of October and stay in the country until the middle of January. During this period he will visit Mohenjodaro and Harappa, Chanhudaro and Amri, Taxila and Sarnath, Nalanda and Paharpur and other centres of archaeological activity in Northern and Southern India. This will enable the officers of the Archaeological Survey of India to exchange views with him as regards the technique of exploration. Advantage will also be taken of Sir Leonard's visit to utilize his vast experience of exploration for the purpose of suggesting sites which promise the best results from intensive exploration. In a country of the size and archaeological wealth of India, selective exploration is essential to derive the maximum benefit from the limited funds that are likely to be available for expenditure of this kind.

Sir L. de Woolley is best known as the excavator of Ur of the Chaldees, the city from which according to the Bible (Genesis) Abraham went away to the deserts westwards to escape from the cult of polytheism. Recently many of the stories recorded in the Bible are finding corroboration as a result of excavations carried out in the Near East, but probably no excavation of recent years has been more striking in its results than that of Ur by Woolley. This place is now a railway station on the Busrah-Baghdad railway, about four hours' railway journey from Busrah, and is marked

by a large mound. Excavations were carried out previously, and these showed that Ur was a flourishing Sumerian city from nearly 3000 B.C. to about 2000 B. C, and at times claimed hegemony over all the cities of Sumer. Though now about 400 miles from the seacoast, it was, in the days of its prosperity, a seaport. Its decline was due to the rise of Babylon about 2000 B.C. as the ruling city of Mesopotamia.

Sir L. de Wooley's excavations which were carried out between 1923, and 1930, and are described in a popular way in *Ur of the Chaldees* has brought to light layers belonging to the times of the earliest Mesopotamian Kings Mes-annipa-da, as well as the funerary deposits in the tomb of Queen Shubad. But the most startling of his work seems to be that which is supposed to confirm the story of Noah's deluge. By sinking a vertical shaft, he came at a depth of 40 feet to a layer which was not virgin soil, but simply a bed of clay about 8 feet in thickness. Driving the shaft still further, he found remains of human habitation in the lower layers up to a great depth. It is supposed that the clay deposit was the result of a great river flood which overwhelmed the city, and laid it over with silt to a depth of 8 to 10ft. The next dwellers simply built over the old city-site.

Visitors to Ur are also pointed to a supposed residence of Abraham, who if he was a historical personage, might have been Wazir to a Sumerian King. There is also the impressive Ziggurat due to the Sumerian king Ur Nammee (2400 B.C.)

We hope that Sir L. de Woolley's visit to India will be fruitful, and we may invite the attention of the public to an editorial article in SCIENCE AND CULTURE of January 1936 about the ideals of archaeological research, and about the vast work lying before Indian archaeologists. It is also necessary that young Indian archaeologists should be sent abroad, and be allowed, by mutual understanding to participate in the excavation work done in Egypt, Syria, Palestine, Irak, Persia and Crete. This will widen their angle of vision, and enable them to learn the latest techniques of excavation, observation and preservation of antiquities.

Duration of the life of Fossil Man

It is usual to say that the longevity of man is constantly increasing with the betterment of the conditions of life, with abundance of nutrition, with the progress of hygiene, medicine and surgery. In France the mean duration of life was 38 years about 1835, but it now exceed 54 years. What was the condition in ancient and pre-historic times?

M. Vallois has collected all the relevant data regarding fossil man which he has presented to the 10th International Congress of Pre-historic Science held at Oslo, and he is going to publish a fuller account in the Journal, '*L' Anthropology*'.

By examining the degree of attachment of the long bone to the skeleton or by noting the stage of eruption of the teeth it is possible to determine within a year or two the age of the infant or the adolescent; amongst adults the estimation is less precise because it depends upon the degree of the use of the teeth and above all upon the degree of attachment of the bone to the vault of the cranium. Both appear to be more premature amongst fossil men than amongst the modern.

M. Vallois has examined from diverse point of view 187 subjects of which 20 belong to the Neanderthal race, 102 to the upper-paleolithic, and 65 to the mesolithic age. For the neolithic age there were not sufficient data but there were 273 observations by Franz and Winkler and 141 by Spiegelberz and Pearson upon the Egyptians of Roman times.

All these facts have been collected and put together by M. Vallois within the following table.

	Age of death in years.				
	0—14	14-20	20—40	41—60	More than 60.
Neanderthal	40	15	40	5	0
Upper paleolithic	24.5	9.8	53.9	11.8	0
Mesolithic	30.8	6.2	58.5	3	1.5
Bronze-age	7.9	17.2	39.9	28.6	7.3
Egyptian of Roman Times.	17	17	39.7	16.3	13.4
Austria 1829	50.7	3.3	12.2	12.8	21
Austria 1927	15.4	2.7	11.9	22.6	47.4
France 1896-1905	25.3	2.6	11.5	17.3	43.3

The discrepancy relative to children appears to be due to the fact that they were often buried outside the burial ground.

In spite of that, the table shows clearly that the duration of human life has been increasing constantly.

Old men were unknown till mesolithic times begin to count from the age of Bronze, but it is really during the last century that their proportion became considerable.

M. Vallois concludes, contrary to what Metchnikoff thinks and what many of the biologists write, that it is probable that the premature mortality which we have verified amongst our ancestors is the one which corresponds to the normal state of man. The length of life observed in our day may be regarded as a secondary phenomenon due to the very new conditions of life created by civilization. Thanks to these conditions the modern man can live up to a period where the enfeeblement of his physical forces and the reduction of his activity will have rendered him incapable of living within a primitive society (*La Nature*, Feb. 15, 1938).

Crisis due to Overpopulation in Poland and its Economic Condition

Under the title; 'the drama of an overpopulated country,' M. Debeauplan tries to show the great effort made by Poland in course of the last 20 years for shooting up to the level of a great modern nation. The creation of the port of Gdynia (at present the first port of the Baltic Sea), the construction of 2,000 K.m. of rail road, 2,000 K.m. of roadway, show it abundantly. But Poland already with 34 millions of inhabitants is going to increase its population each year by 400,000. This population is 60% rural, and very dense for a territory having an area of 388600 K.m. square. If one admits that for 100 hectares (247 acres) of cultiviable land, there should be a maximum of 30 agricultural workers, we find that this figure reaches in Poland the value nearly 50 (exact figure is 48). The figures in other countries are as follows:

France,	..	..	.. 23;
Belgium,	..	..	.. 33;
Holland,	..	..	.. 27;
Germany,	..	..	.. 30;
Italy,	..	..	.. 44;
Denmark,	..	..	.. 15;
(India,	..	..	52?).

Now considering the fact that there are 20 millions of peasants in Poland we find that if Polish peasants were to live up to the standards of other European countries, 10 milions of the these individuals should have some other occupation than agriculture. In Poland the *salary of the agricultural workers varies* from 35-120 francs per week (Rs. 2½ to Rs. 8). But this salary is only on paper; to find out the actual buying power this salary ought to be divided nearly by half. It is therefore not strange that a Polish citizen consumes 8 times more potato than a British citizen, but 5 times less sugar. We have very often remarked that the industry of a nation depends on the prosperity of its agriculture, therefore we are not surprised to find that there is an underproduction in the Polish factories, which is becoming more and more accentuated (In 1929 there were ·84 million factory workers, in 1936 it has fallen down to ·6 millions; the number of working hours has decreased from 1·6 billion hours to 1·12 billion hours. The number of unemployed has nearly quadrupled within the same period and the general index of salary has fallen from 100 to 53 in 1936. In order to improve these conditions certain notables in Poland advocate that the frontier should be extended at the expense of Czecoslovakia and Russia (frontier of 1772). This is a menace for the Ukraine, but such an idea find happily very few partisans. The Warsaw Government wants to organize emigration on the other side of the Atlantic and the project is before the League of Nations. But all the projects have so far been theoretical, practically one does not see how Poland where the misery among the labouring classes has been very intense can find out remedy for the consequences of overbirth. We have very often commented how overpopulation has caused (in course of historical times vast migration of people from the over-populated and relatively poor countries to the territories of other nations. If Poland suffers from a rate of increase in the number of inhabitants which is the highest in Europe, France suffers from the continued crisis of under birth, because, according to the census of 1938, the total population is only 42 millions of which 3 millions are foreigners settled in France.

--*La Science et la Vie*

Travancore Scheme for Conservation of Ancient Monuments

As a step in the systematic conservation of ancient monuments in Travancore, a survey by the State Archæological department of monuments having a historical, archæological or artistic interest in the State is now in progress. The result of this survey, so far available, show that among the most ancient of these

monuments are Hindu temples, some of which date as far back as the 8th century A.D. A passing phase of Pallava influence is evident from some of them, as is shown by the close resemblances of the cave temples at Kaviyur and Tirunandikara to Pallava work outside the State. Specimens of both early and later Chola architecture, as well as of the Vijayanagar period, are also to be found, while the Kerala style, which is more common, is distinguished by gabled roofs, wood carvings and absence of spires. Besides, specimen, of *vimanas, gopurams and mandapams,* characteristic of the early Chola, later Chola and Vijayanagar periods respectively are found in a good state of preservation, and a study of their architecture is engaging the attention of the Archaeological department.

The Government of Travancore have, in this connexion taken steps for the preservation of such of the ancient rest houses (*vazhiambalams*) as have an artistic architectural or historical importance, and have sanctioned an annual grant for the purpose. There are over 125 such rest houses, in the State, some of which have ornamented and sculptured pillars of great artistic excellence. A few of them date from the 10th century A.D., as is shown from the evidence of inscriptions.

Triennial Review of Irrigation in India

The *Triennial Review of Irrigation in India* for 1933-36 which has recently been released for publication is a helpful guide to know what the state of irrigation in India is at present, and what schemes relating to it have materialized.

With a steady increase in yield and acreage crops worth over Rs 100 crores were raised from areas receiving State irrigation alone during the year 1935-36. From about 10½ million acres in 1878 79, the area annually irrigated by State works alone has now risen to about 31 million acres—nearly ⅛th of the total cultivated area in British India.

The total capital outlay, direct or indirect, on irrigation and navigation works amounted, at the end of 1935-36, to over Rs 153 crores, the gross revenue for the year to about Rs 14 crores and the working expenses to about Rs 5 crores, thus yielding a net return on capital of about 5·7 per cent.

There are near about 300 irrigation schemes in operation in British India alone, of which 70 are of a major description. Of the 300, a third are classified as productive and the rest as unproductive, *i.e.,* as works constructed primarily with a view to the protection of tracts with precarious rainfall and to guard against the necessity for periodical expenditure on relief in times of famine. Of the provinces in India with extensive irrigation works, the Punjab is easily the first with an irrigated area of over 11 million acres. Madras comes second with nearly 7½ million acres, followed by Sind and the United Provinces with over 4 million acres each. The next is Bihar and Orissa with over 9,00,000 acres. In the percentage of area irrgated to the total area sown, Sind leads with a proportion as high as nearly 90 per cent. followed by Punjab with 35 per cent, Madras with 21 per cent and the North-West Frontier Province with 20 per cent. Bengal is the only province where the area irrigated is less than 1 per cent of the total area sown.

The total average area irrigated in British India during the triennium was nearly 31 million acres, as against 30 million acres in the previous triennium, Sind and Bengal contributing largely to the increase due respectively to the functioning of the Lloyd Barrage cannals since 1932 33 and the extension of irrigation in the area commanded by the Damodar Canal. There has been an increase also in the United Provinces attributable mainly to the construction of the State tube-wells and the development of the sugar industry. The only decrease of any importance in the area irrigated was in the Central Provinces, where it was due to the character of the seasons and the economic situation. As in previous years, during 1935-36 also the Punjab showed the largest return on capital invested in productive works, namely, 14·2 per cent, followed by the North-West Frontier Province with 8·4 per cent, Madras with 7·4 per cent, Bihar and Orissa 6·7 per cent. Of the irrigation works of any importance completed during the triennium, by far the largest is the Llyod (Sukkur) Barrage and Canals construction scheme. With its 6,600 miles of channels and 48,000 miles of water-courses capable of drawing 46,000 cubic feet of water a second from the river, it is by far the largest canal system in India—possibly in the world. Its largest canal is the broadest ever excavated and exceeds the Panama Canal in width at bed level. The scheme commands a gross area of 7½ million acres—an area roughly equivalent to a quarter of England and more than the entire area irrigated in Japan. About 6½ million acres, or as much as is actually irrigated in Egypt, are cultivable; and it is estimated that about 5½ million acres or an area

about the size of Wales, will actually be irrigated annually when the project has been fully developed. With the completion of the system of canals, its cost went over Rs 20 crores, and it is expected to yield a net return of 7·39 per cent ten years after completion, that is, in 1942-43.

The other great engineering work, completed during the period under review, is the Cauvery Mettur project. Framed with two objects in view, the first, to improve the existing fluctuating water supplies for the Cauvery delta area of over a million acres, and secondly to extend irrigation to a new area of over 300,000 acres, the project involved the construction of a large dam on the Cauvery at Mettur and of an irrigation canal (the Grand Anicut canal) taking off on the right bank of the Cauvery, and the improvement and extension of the existing Vadavar canal. Easily the first among those in the British Empire and believed to be the second or third dam in the world, the dam at Mettur is over a mile long and impounds a 60 square-mile lake with a shoreline of 180 miles and a maximum effective capacity of about 94,000 million cubic feet of water. Estimated to cost about Rs 662 lakhs for all works, including hundreds of miles of canals and distributaries, the project is expected to yield a net revenue of over Rs. 50 lakhs. Details are also given in the Review of the other important schemes, including irrigation projects navigation channels and embankment works, now under consideration in the different provinces. Of these mention may be made of the Haveli Project now under construction in the Punjab. Estimated to cost about Rs 535 lakhs, the project is expected to yield a net revenue of over Rs 43 lakhs, or a return of about 8 per cent on the expenditure involved. The primary object of its construction is to irrigate the land lying along the banks of the Chenab, below the junction of the Chenab and Jhelum, and to improve the water supply of the Sidhani Canal and of the Chenab inundation canals in the Multan and Muzaffargarh districts. The project consists of three distinct but inseparable parts, namely, the construction of a barrage below the junction of the Chenab and the Jhelum, the construction of a link between the Lower Bari Doab Canal near Montgomery and the Pakpattan perennial canal, and the provision of a winter water supply to the Burala branch extension of the Lower Chenab Canal. It is estimated that the project will provide a probable perennial irrigation for over 555,000 acres and a probable non-perennial irrigation for over 450,000 acres in the Haveli Canals tract and will, in addition, irrigate 128,000 acres on the Montgomery Pakpattan link and over 38,000 acres on the Burala Branch Extension.

In Madras a large project for impounding the waters of the Tungabhadra river has been under consideration for a long time. Technical and financial difficulties and the problem of reconciling rival claims to share in the waters of the river have stood so long in the way of the execution of the project. The general question of the allocation of the waters of the Tungabhadra is now under examination by the Governments concerned. Another large project under consideration is the Lower Bhawani project. Drill borings along the line of the proposed dam were completed, and experiments on the duty of water for dry crops irrigated by flow were conducted in certain areas under the project conditions. Observations were also made on transmission losses in certain channels. The Government of Madras have undertaken to spend a sum of Rs. 50 lakhs spread over three years on a widespread scheme of improvements to the minor irrgation works, as a measure of economic relief and to reduce rural unemployment in Madras, and good progress has generally been made. In Bengal, the work in connexion with the detailed survey and investigation of the Darakeswar Reservoir project, which is intended to irrigate 1,80,000 acres, was in progress during the period under review. Discharge observations have been made during the monsoon seasons to ascertain the supply available in the river. A contour survey of far-reaching importance in parts of Central and Western Bengal was commenced in February 1936, with a view to determining the possibilities of extending irrigation and improving the drainage and sanitary conditions of the tracts by large schemes, such as the More Reservoir scheme and the Darakeswar Reservoir scheme, and therby of developing that area.

In the Lower Kumar river, a navigation channel of considerable improtance, locks and sluices have been put in with the object of controlling silting in the river, at a cost of about Rs. 7½ lakhs. The locks and sluices can be so operated as to control the flow in the Lower Kumar river, but the silting troubles, though reduced, still continue and a final solution has yet to be found. Owing to financial stringency the dredging programme in the Lower Kumar river was of a restricted character. As a result the river was navigable to large steamers from May to November each year, and to shallow drafted steamers and boats during the remaining months.

NOTES AND NEWS

Another navigation channel of considerable importance, in Bengal is the Attrabanks river, which forms a cross country connexion between the Rupta and the Madhumati rivers. Unusually tortuous from its junction with the Bhairab river near Alaipur to the river Madhumati at Asthail, it is becoming badly shoaled. The depth of river is so reduced in winter that the shoals are not navigable without extensive dredging. During 1934-35 and 1935-36 the condition of certain shoals became so bad that steamer traffic through this river had to be closed and diverted along the Madhumati river and the Attya Halifax Cut Route. In this diversion route, too the Mangalpore and the Haridaspur shoals in the Madhumati river had to be dredged in the years 1934 and 1935. A policy of gradually abandoning certain protective embankments, which with experience have been found to be of harmful effect because of the obstruction caused to river spill, was continued in Bengal during the period. In the United Provinces, the proposals for the Nindeh reservoir for the extension of irrigation on the Garai canal system in the Mirzapur district are being reviewed with a view to utilizing the scheme for development of electric power. Investigations were also made during the period for extending urban electricity and irrigation by means of electrically driven tube-wells, and canals fed by water pumped by electric power from rivers, into certain tracts of eastern Oudh not commanded by the Sarda Canal. Projects for three canals taking off from the Gogra, Kalyani and Gumati river were proposed.

As a preliminary step, a small scheme has been sanctioned for pumping 160 cusecs from the Gogra River and the erection of a power house at Sohawal Railway Station to supply energy for working the pumps and electrifying Fyzabad town. The canal is designed to irrigate over 13,000 acres annually. The expansion of similar power irrigation in Eastern Oudh will depend on the results of this experiment. An important work in progress in Baluchistan was the Quetta storm water drainage and embankment project at an estimated cost of Rs 2 lakhs. The project is designed to protect Quetta from the periodical damage caused by flood water. The existing drainage channels passing through the town are being improved so as to increase their discharging capacity and the vents of the bridges are being widened with a view to facilitating the passage of flood water through the town without causing any damage. The expenditure on the project up to the end of the year 1935-36 was about Rs 2 lakhs. The irrigation projects in Bombay now under consideration are the Kelegaon Tank project and the Waldevi Tank project. The first is intended to supplement the storage in the Ekruk tank at Sholapur, with a view to meeting fully the irrigation requirements of the tract under command and also the non-agricultural needs of Sholapur town with its cotton mills. The object of the Waldevi tank project is to provide Nasik town, Deolali Cantonment, the Great Indian Peninsula Railway and the Government Central Jail with an adequate supply of water. In the North-West Frontier Province, projects for lift irrigation of the area near Risalpur, and for the control of the Tank Zam and the Gumal River, are being considered.

Thyratrons for Grid-Controlled Rectifier Service

It is common knowledge that the output voltage of a rectifier fluctuates with changes in load current and supply line voltage. Frequently these fluctuations are so large that means must be used to correct them. This is particularly true when the rectifier feeds a load having a high back electromotive force and a small resistance, such as a storage battery. The facility with which the output voltage may be controlled by the use of thyratrons as the rectifying element has encouraged the design of tubes especially suited to this purpose. There is available a variety of circuits such that the output voltage of a rectifier may be made to obey any desired law. The successful application of these circuits depends upon the degree of reliability of the thyratron tubes used in them. To be most successful the tubes must possess certain characteristics. This paper (G. H. Rockwood, *Trans. the Electro-chemical Soc.*, 72, pp. 213-224, 1937) gives a brief review of the operation of grid-controlled rectifier circuits impose on the tube characteristics, and describes a particular type of thyratron with mercury-plus-argon filling which has proved especially useful in such rectifiers (Abstract from *Bell Sys. Tech. Jour.*)

SCIENCE IN INDUSTRY

Handloom Industry in Bihar

At the third conference of the textile section of the Department of Industries, Bihar, Rao Bahadur K. S. Rao, Textile Expert to the Bihar Government, in making a review of the work done so far for the development of cottage industries in Bihar, said that they had been neglected by the educated classes and left to the care of mostly illiterate and conservative artisans. The products of such industries were, therefore, comparatively more expensive than the corresponding machine-made articles. The designs and patterns handed down from ancient times and rigidly adhered to by the indigenous workers often failed to satisfy modern taste. Due to these causes the Bihar artisans were slowly losing their markets and were forced to give up their ancestral professions for more secure and remunerative occupation. The efforts of the Department of Industries in Bihar have been directed towards increasing the efficiency of the village artisans, the hand-weaver in particular, and towards improving the quality and style of their products. In spite of the best efforts of the demonstration staff of the Department in the way of equipping the weavers with labour-saving appliances and thereby improving their productive capacity, however, the results have so far not been quite satisfactory. For instance in the course of the last 18 years only 25 per cent of primitive looms or 40,000 out of the total number have been replaced with improved flyshuttle looms which increase the efficiency of the weavers by 50 to 100 per cent. By the introduction of the use of long warps with improved warping drums, the progress has been still less marked. But efforts in training the weavers to weave better class of fabrics have been more successful. The Bihar weaver was now able weave to and supply fabrics to satisfy modern taste. A great deal of work still remained to be done, continued Mr Rao, before the handloom industry in Bihar could be brought to a state of perfection. In addition to the improvement in the technique of weaving the organization of the manufacture and trade on rational lines was an urgent necessity. For this purpose an experiment was being conducted which was of importance not only to Bihar but to other provinces and States in India. The trade organization called the Bihar Cottage Industries was started in April 1936 with a grant from the Government of India embodying in it all the important economic principles of modern factory industries except in the details of actual manufacture. While centralizing the purchase and dyeing of raw materials and finishing and marketing of finished goods the various operations of weaving were being carried on by weavers of different villages in their own cottages. The weavers in this organization were having the freedom of working at their own time and were availing themselves of the services of their family members who would have been without work otherwise. The products of the weavers were standardized and were manufactured on mass product basis. The woven goods were collected in a central place and were made attractive by bleaching and finishing. In these processes only such machines were employed as were indispensable. This experiment of organizing the trade of cottage workers was being carried on for the last three years and the results achieved so far have been satisfactory. The Government of Bihar have proved that the Indian hand-weaver can manufacture even art-textiles against standard specifications on mass production basis and market the goods successfully even in foreign countries. It was proposed to work this model organization till similar organizations were started by the educated classes for their own advantage and that of the artisans in the village. Besides rendering technical assistance to the adult artisans and maintaining a model trade organization for their benefit the Department also trained young men in various handicrafts with a view to producing not only a more efficient class of artisans but also to create a new class of leaders or organizers required for the development of the industries.

Mr. V. K. B. Pillai, who presided, in his address said that agricultural operations in India were seasonal,

entailing long periods of idleness among the rural population. This maladjustment could be remedied only by the provision of cottage industries as subsidiary occupations; and of the cottage industries hand weaving by its traditions and economic advantages stood pre-eminent. A well-planned development, he added, of the cottage industries would go a long way in introducing diversity of occupation so essential for the economic utilization of the surplus man power which is running into waste.

Economic and Industrial Conditions in Bombay

The Bombay Economic and Industrial Survey Committee have formulated a statement of the detailed heads of inquiry under which they are trying to collect information regarding the economic and industrial conditions of the Province of Bombay. Copies of this statement can be had from the office of the Committee by such members of the public as are in a position to supply information on the economic and industrial conditions and possibilities of the Bombay Presidency. The kind of information the Committee is anxious to have can be briefly summarized under three heads, *viz.*, (1) the existing industries of the province of Bombay, (2) possible new industries that could be started in the province, and (3) observations on the work done by the Government of Bombay in the realm of economic and industrial development so far, and suggestions about what could be done in the future.

Under the first head, the Committee is anxious to get information separately on rural and urban cottage industries. They are anxious to get historical notes on such rural and urban cottage industries as are in a state of decay, with special reference to the reasons for such decay; thus, for example, they would like to know whether the decay is due to changes in taste, or foreign competition, or internal competition from machine-made substitutes, or whether it is due to faulty technique and marketing and financial difficulties. Such an analysis would be useful from the point of view of estimating the possibilities of the revival of these industries. With regard to the existing industries which may be under going difficulties, but which cannot be said to be in a state of decay, the Committee would like to get information on the topics of periodicity of employment, competition, markets, finance, organisation of the industry, and so on. Suggestions are also invited regarding measures, legislative, administrative or financial, which could be undertaken by the provincial Government, with a view to helping the existing industries of the province. Under the second head, suggestions are invited from the public particularly from traders and other engaged in, or coming into contact with, industrial pursuits, about possible new industries which could be started in the province having regard to the availability of raw materials and markets in the province. A large number of commodities of foreign manufacture are being consumed in the province to-day, and there is no doubt that a number of these could be replaced by articles of domestic manufacture. It is very difficult to get into touch with all the persons who have made attempts to manufacture something or other, which could replace a foreign product. It is therefore requested that all persons who have experimented on new industries should get into touch with the Committee and place before it their views and suggestions regarding the possibilities of developing new industries. It is also requested that such persons should also indicate measures which they expect Government to undertake to help in the starting of these new industries. Under the third head, the Committee would welcome observations on the work done by the different departments of the Government of Bombay, such as, the Department of Industries, the Department of Agriculture, the Department of Co operation, the Department of Forests, etc., in the matter of promoting the economic development of the province. Such observations may be made in a critical spirit, but it suggested that these should be based on either a study or a first hand knowledge of the activities of the department concerned. Observations are also invited on what the Government can do in the matter of promoting the economic development of the province, and the Committee will gladly welcome any concrete proposals for economic development which may be placed before them by members of the public.

The foregoing remarks indicate in an adequate measure, the kind of work on which the Committee is engaged; and members of the public, who are in a position to help this Committee by supplying them with information on all or any of the items mentioned above, would be rendering the Committee and the Province a good service by doing so.

We may remark in conclusion that what is being done by the Bombay Government for the revival and development of the native industries should be followed in other provinces too, especially in Bengal where her indigenous industries are mostly in a decadent state.

Air-Conditioning in Indian Railway

Speaking at a meeting of the Calcutta Rotary Club on July 5, 1938 on the advantages of air conditioned travel on Indian railways, Mr L. P. Misra, Divisional Superintendent, East Indian Railway, Howrah, first stressed the fact that the amenities provided in first class carriages on Indian railways compared favourably with those on railways in any other country. Nevertheless, the fact remained that upperclass travel had not met with that response from the public in this country that it deserved. The climatic conditions, the extremes of temperature, the dust and the noise so inseparable from travel in tropical countries added to the discomforts of journeying and tended to keep passengers away. The railways in India had, therefore, to devise methods for overcoming these discomforts, and one means they had adopted was airconditioning. In America, which was the pioneer country in the adoption of air-conditioning, several systems were in vogue. Conditions obtaining in India, however, made it impracticable to adopt a number of these systems. The system now generally in use in India was the electro mechanical system.

After explaining the technical aspect of air-conditioning, Mr Misra said that it had been discovered that if 25 per cent of the total volume of air that was passed through the coach was fresh, it would be ideal for the human body. The air that was supplied inside the coach, was first filtered, the moisture reduced and then it was passed through ducts. Under the electro-mechanical system it would be easy to heat the carriages in winter. What would have to be done was to put out of action the cooling coils, and set up a contrivance for heating the air. Mr Misra said that on the B.B. & C.I. Railway air-conditioning was brought about by a system known as the ice-activated system. Ice was placed in the underframe, over which the air was made to pass. The air became cool in the process. Both systems—electro-mechanical and ice-activated—were on trial, and the Railway Board were not committed to either of them. But the electromagnetic system had this advantage, that it was more scientific, and by it , the temperature could be regulated with much more accuracy than was possible under the other system. Mr Misra said in conclusion that people who had travelled in air-conditioned coaches spoke highly of the advantages of the system, and in his opinion the prospects of the general introduction of air-conditioned coaches on Indian railways were very bright.

We should in this connexion invite the attention of our readers to the following article on " Air conditioning for Comfort " by Professor P. N. Ghosh. The article deals with in short the different aspects of air conditioning, and gives in some detail how the temperature of a room, house, etc., can be controlled according to our liking.

Air-Conditioning for Comfort

P. N. Ghosh

Ghose Professor of Applied Physics, Calcutta University.

There has been recently a move all over the world for controlling the weather inside dwelling houses. Though, to the ordinary mind, the idea may appear to be a high-priced luxury, yet, when one takes account of the realities, it forms an expectation that may within recent years be fulfilled for moderate dwellings. Human beings have developed the sense of comfort with the growing amenities of life supplied by mechanical developments of the last century, and one of the most noticeable is that of controlling the physical properties of the atmosphere so rarely found to our liking.

Within the last decade there has been very large progress in this direction, and it is now possible to maintain the air within an enclosure at a satisfactory standard of purity and with a combination of temperature and water-vapour content suited to the health requirement of persons exposed to it. It should be necessary to point out that the condition so created shall be automatically controlled without the need of human element for adjustment.

Beginning of Air-Conditioning

The term " Air-Conditioning " which is being more and more common nowadays was first coined in U. S. A. in 1907. In 1911, W. H. Carrier read a paper before

the Society of Mechanical Engineers on "Rational Psychrometric Formulae," their relation to the problems of meteorology and air conditioning and the basic principle enunciated in that paper forms the background on which the modern methods of "air-conditioning" are based.

Even in the States with its extremes of climate and with people always ready to give any new idea a trial, it was only for industrial application that the practice of air-conditioning found favour. This, however, had its advantage as the practical feasibility, the success and failure of the application were under the direct observation of trained men. Modifications were soon introduced, improvements made, and the commercial possibility of equipments from the basic knowledge of the natural laws affecting the design soon sufficiently advanced to get a successful start.

Contrary to usual practice, experiments were done in large installations treating a whole building to the equipment. Thus in Rio de Janerio in Brazil, the first public theatre was air-conditioned at a cost of £50,000 in 1911 through the efforts of German engineers. In the States large number of hotels and public places soon took up the idea, and comfort of air conditioning in big installations, where cost actually was of no consideration, became a reality. It has now spread all over the world in many public institutions and public undertakings.

Essentials of an Air-Conditioning Plant

The first essential of any air-conditioning plant is that it must be capable of controlling accurately the temperature, humidity, purity and circulation of air within a given enclosure irrespective of the state and variation of outside atmosphere, thereby regulating the effects of such air on materials and on people exposed to it.

The combination of temperature and relative humidity that ensures comfort has been found from a very large number of trials in America as well as in the Continent of Europe, and it has been found that in winter a temperature range of 60° to 70° F and in summer of 70° F and 75° F with 45 to 60% of relative humidity ensures the comfort condition. There is another point of importace namely the control of air movement, as the human body is particularly sensitive to draughts, and proper air-conditioning should ensure the absence of these draughts.

Starting from outside air one has to abstract heat and ensure adequate dilution of deleterious gases, smoke, odours, so that pure and fresh air may be admitted into the enclosure. It is well known that the total heat content of air in any given state is the sum of sensible and latent heats due to the presence of water vapour in the atmosphere and the regulation of the absolute moisture content of the air has to be secured with the help of a device which should be capable of very close automatic regulation. If the natural moisture content is greater than that necessary, the excess is precipitated with the help of finely atomized spray of chilled water which has to be constantly recirculated and passed through the evaporator or a mechanical refrigerating plant. In places where air-heating is required in winter, there is the need also of a spray-chamber to add the desired humidity to the air in question. Successful air distribution calls for even diffusion without draught and the present tendency is to use high velocity outlets up to about 2,000 ft. per minute with an entering air temperature of 20° F below that of the conditioned space.

The field of refrigeration in air-conditioning is entirely different from those of ice-making and general low temperature work. The refrigerant shall be non-toxic thermo-dynamically efficient, compact and reliable.

The air-conditioning apparatus can be divided into three classes—

(*a*) Winter conditioners, with means of heating and humidifying;

(*b*) Summer conditioners, with means of cooling and dehumidifying;

(*c*) Year-round conditioners, which would have means to serve all the purposes.

Air-Conditioning in U. S. A.

It would be interesting in this connection to have a review of the conditions prevailing in the United States of America within the last few years.

"By the summer of 1936 the man who worked all day in an air-conditioned office, who travelled in air-conditioned trains, who lunched in air-conditioned restaurants, was beginning to demand at least summer cooling and dehumidification in his own home; and so to

guide him to his expected ideal, in 1937 the manufacturing and supplying sides of the electrical industry developed suitable units for year-round air-conditioning as a standard equipment for new demonstration homes. In 1938 standardized unit conditioners ranging in size from 5 ton to 3/4 tons cooling capacity are coming into prominence as suitable units for residential blocks and cottages. The manufacturer foresees the time when air-conditioning small units are going to be as popular as gas and electric cooking ranges and home refrigerators. It is expected by the electrical concerns that in 1938 this factor would come up to 250,000 units.'

The Equipment

The most common type of equipment is the central fan plant to draw in and treat the fresh air required in the building at one point and then distribute the air by means of several ducts to the different portions of the building and a separate system to bring back the air for re-treatment and re-circulation. Instead of one central plant and number of ducts, sometimes number of unit conditioners are fixed as independent units. The conditioner comes from the factory already assembled, and on installation site requires only fresh air, electricity and water connections to work the cooling coils and the surface heaters and precipitators. For summer conditioners, as no heating arrangement is required, but refrigerating and dehumidifying form the essential components, the system in a sense becomes less complicated.

Air-washer and Dust Eliminators

The spray-type air-washer of humidifier is actually a low pressure boiler adding water vapour to the air first passing through it, *e.g.*, with wet and dry bulb temperatures of 100°F and 65°F corresponding to a rather hot dry day, the air-washer installation has to increase the water vapour content from 66·9 to 96·3 grains per lb. Tables have been constructed by which it is possible now to get a fair regulation of the humidity factor and cleaning factor of the air within the close approximation.

It is interesting to note that within the past few months a number of dust-extractors of the electrostatic filter type have been put on the market in small sizes for home, shop and office use; the dust-laden air is drawn round ionizing wires charged to 12,000 volts and then passed through a series of alternately spaced high potential and grounded plates. The dust particles after being negatively charged adhere to the positive plates which are charged to about 6,000 volts and have a thin coating of oil to assist adhesion of the dust particles.

The important factor in filters is not simply the removal of certain percentage of dust by weight but rather the effectiveness for removing certain objectionable constituents of the air which may be the finest particles present or the coarser ones within a certain range. For instance pollen grains and types of dust, producing asthma or hay fever generally fall to within 15 to 50 μ range and most filters now used in air-conditioning plants are capable of removing 98% in number of these particles.

It can easily be imagined that the atmosphere prevailing in enclosed spaces require considerable amount of water-spray to render the air free from impurities and an arrangement for dust-free air would require fairly large quantity of water for its proper conditioning. For large establishments evaporative condensers have been adopted in which the condensing coils are placed directly underneath the water-spray system and a pump lifts this condensed water for the purpose of make-up. Outside air is drawn up through water-covered coils, then through eliminator plates to remove excess moisture and finally forced up by a number of fans suitably placed on the top of the unit.

In mechanical cooling systems though ammonia was most generally used, within the last two or three years *Freon* is the most popular refrigerant. It is a dichloro-difluora-methane refrigerant. It is favoured for air-conditioning plants, because it is said to be non-toxic in concentrations up to 20% by volume for a period of 2 hrs.

Dehumidification

The most commonly used system for dehumidification is by cold surfaces, the temperature of the surface being kept low by refrigeration. Where cold water is available water circulation is resorted to. For quick evaporation and absorption silica-gel is used along with suction pumps and are found much more effective than the old calcium chlroide absorbers. Following the experience gained in oil and gas industries in America, lithium chloride and activated aluminium show great promise in this line. The general practice of drying up

the absorbents is that of electric heating which liberates the absorbed water fairly quickly and is coming more and more into prominence in America. Regarding the sizes of dehumidifiers one finds for the silica-gel units at present four sizes namely six hundred, fourteen hundred, two thousand seven hundred and five thousand cubic feet of air per minute.

Humidity control is now being closely maintained automatically; and the temperature is arranged on a sliding differential between the inside and outside conditions to avoid risks of shocks to persons coming into or going out from the conditioned spaces. A number of thermo-stats, hydro-stats with their control valves are worked either by compressed air or by electrical relay units.

Air-Conditioning in England

In England there is no scope for any spectacular summer cooling and the majority of plants are arranged for year-round use. This year there had been an attempt to secure data regarding air-conditioned plants. A questionnaire was sent out in January 1938 to two hundred and thirty electric supply concerns of Great Britain up to the end of February 1938, 130 replies were received.

Ten authorities reported on twenty one industrial installations totalling 4746 H.P.

Five authorities reported on nine comfort installations in restaurants and cinemas totalling 1818 H.P.

Seventy two authorities reported on partial air conditioning systems in cinemas and public buildings, the installations consisting mainly of dust washers and heaters with plenum ventilation requiring motors, fans, and pumps totalling 2508 H.P., *i.e.*, with an average of 20 H.P. per installation.

It is estimated that the total load for air conditioning in Great Britain at the end of 1937 amounts to roughly about 70,000 H.P.

Installation and Maintenance Costs

Regarding the actual cost calculated on the basis of experience for the cinemas and public places one can broadly state that for a 2,000—seat cinema the annual cost for heating and plenum ventilation would be £4,500 and for complete air-conditioning £15,000 per year *i.e.*, an additional cost of £11,000 per year or a monthly expense of £900. The cinema people can well afford to bear this additional cost to attract sufficient number of visitors to pay for their own cost for comfort in the cinema.

Advantages and Uses of Air-Conditioning

In considering the desirability and the usefulness of air-conditioned residential quarter and office establishments it is well worth pointing out that more hours of ill-health were caused by the common cold with its sneezing and coughing than by any other ailment. The first three days of cold are those when there is a great risk of infecting other people. Considerable amount of experimental work in America and in England and the continent had been conducted and as a result it has been found out that when persons suffering from a cold were shut up in a room with others in normal health, (*a*) if the room not air-conditioned the cold infection spread to more than 60% of the people in sound health, (*b*) if the room air was conditioned the infection did not spread more than 5%. Many large and small air-conditioned offices in America kept records of time lost mainly through illness and the reduction in absentees is as high as 40% compared with the period before the equipment was installed. Moreover invigorating atmosphere led also to higher efficiencies in the office.

Of Benefit in Asthma and other Diseases

Patients suffering from asthma and hay fever being put into air-conditioned rooms reported relief and this lasted (from hours up to days) after they left the rooms. If recovery had been made in an air-conditioned hospital ward it could be maintained provided the patient is kept in an air-conditioned bed-room. In the treatment of circulatory diseases constant and favourable degree of temperature and humidity beneficial to the patient could be maintained. As a result of recent experiment there is promising evidence that air-conditioning could be effectively applied to the cure of tuberculosis in its early stages even under trying weather conditions such as prevail in the tropics. It is expected that within three or four years experimental evidences would convince the medical profession the value of air-conditioning plants for their patients.

Other Uses

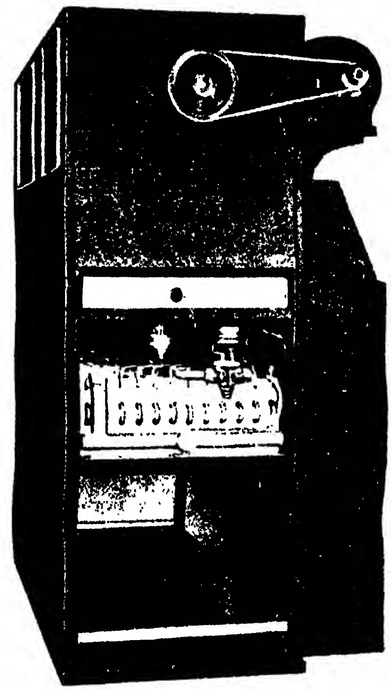
From experiences in America it has been found that for very small residential installations air-conditioning prevents wooden furnitures and fixtures in a house from over drying and resultant shrinkage and warping in dry

winters. In damp weather it prevents walls and windows from weeping, growth of mould is discouraged, carpets, curtains fabrics and specially library books keep much better due to free from dust and absorption of moisture.

Within the last five years the introduction of air-conditioning storages in America have shown less chance of wastage and a considerable saving in the value of food stuffs otherwise lost. The wider adoption of the idea is being retarded on the part of the customer due to (1) reluctance to pay more first cost (2) lack of confidence in estimated annual savings (3) lack of understanding of the proper tariff schedule by the electricity concerns. But these factors have now been investigated by the recent National Development Committee.

In 1937 a number of small sized household air-conditioning units have been marketed in America and the inside view of the summer self-contained air-conditioner of Fair bank Morse & Co. of U. S. A. is given in the next column.

Within recent years attempts have been made in U. S. A. to have a small sized dwelling house to have its own air-conditioned arrangement and units are now available for such dwelling houses at a cost ranging from 1,000 to 2,000 dollars and even there are smaller units for single rooms which are commercially available even at Calcutta within the limited price of Rs 1,200 to Rs 1,500/. There is indeed a great future for a comprehensive study of this problem for our country-men and it deserves the attention of the university authorities and other educational institutions to arrange



for proper training and research suitable to our local conditions.

MEDICINE AND PUBLIC HEALTH

The work of Tuberculosis Association of Bengal in 1937

The work of the Association is directed in many lines, chief amongst them are—Dispensary work, Publicity, raising of funds and training of medical men and Home Visitors.

A great stride has been made in the dispensary work. The total amount of diagnosed cases of pulmonary tuberculosis has been 3,757, a rise in number by 594 over the previous year. Besides, 173 cases of non-pulmonary tuberculosis were diagnosed. It is a great pity that 46·5% of all cases came to the clinic in very advanced and 33·5% in moderately advanced stages. About 30% of the diagnosed cases were unemployed persons and consequently neither could afford to pay the minimum cost of Rs. 3/- or 4/- for an X-Ray nor could they have good food and well ventilated houses. The results of treatment, with all these handicaps, had proved to be very satisfactory. Of all the cases treated by collapse therapy 63% improved and 61% were rendered noninfectious. If the association could have more beds at its control, it is confident of showing still better results.

It is rather disconcerting to note from thee report that majority of these cases belong to the age group of 20-30 and the incidence of the disease is increasing amongst the menials. These two show that the disease is sapping the youth and is increasing in people who are the best media for propagation of infection.

The Home Visitor's work had been notable for the year. 33,765 Home Visits were made—a rise in number by 10,098 over the previous year. 4,378 contact cases were traced. Many home visits could not be done and contacts could not be traced as the Association is not yet solvent enough to engage more Home Visitors, though they need them very much.

There has been also a great increase in publicity work this year. 300 lectures were given in schools, colleges, exibitions etc. Besides, the Association had participated in 18 Exhibitions in Calcutta and 8 Exhibitions in Mofussil.

The Association is in urgent need of money. Though this year they have secured a grant of Rs 10,000 from the Government and other collections are greater than the previous year yet there is a deficit in the Budget. They have inaugurated a "Building Fund," a "Feeding Fund" (to supply extra food for the needy) and "Kalyani X-Ray Fund" (to help the X-Ray Examination of those who cannot pay for it,) by collections specially made for these purposes. All these are very much needed and the Association needs more money for these funds to work them to a success.

The Association is the pioneer and the only organization in India which trains Home Visitors. It is turning out a number of them every year. It is also training Medical and Public Health Officers. Since 1935 four such courses were held by the Association.

The Association had done very well in introducing the "new" case cards which permitted of statistical analysis. This will standardise the work and case taking of all the dispensaries and will help a thorough analysis of the rich material the Association possesses. A few years hence, by the help of these "case cards" very important statistical findings could be worked out. We need them very much as without the help of such findings no well directed campaign against tuberculosis is possible.

The Third International Congress for Microbiology

The Third International Congress for Microbiology will be held at the Waldorf-Astoria Hotel, New York City, from the 2nd to 9th September, 1938, under the auspices of the International Association of Microbiologists.

The Congress will be composed of the following 9 sections:—

(1) General Biology: Variation and Taxonomy Convener: C. E. A. Winslow.

(2) General Biology: Microbiological Chemistry and Physiology. Convener: Stuart Mudd.

(3) Viruses and Viral Diseases. Convener: W. A. Sawyer.

(4) Rickettsiae and Ricksettsial Diseases. Convener: Hans Zinsser.

(5) Protozoology and Parasitology. Convener: H. W. Stunkard.

(6) Fungi and Fungous Diseasees. Convener: B. O. Dodge.

(7) Medical and Veterinary Bacteriology. Convener: F. P. Gay.

(8) Agricultural and Industrial Microbiology. Convener: S. A. Waksman.

(9) Immunology. Convener: M. Heidelberger.

The following are the names and addresses of the office-bearers:—

T. M. Rivers, M.D. President, Rockfeller Institute for Medical Research, York Avenue and 66th Street, New York City.

M. H. Dawson, M.D., General Secretary, College of Physicians and Surgeons, 620 West 168th Street, New York City.

Kenneth Goodner, Ph.D., General Treasurer, Rockefeller Institute for Medical Research, York Avenue and 66th Street, New York City.

The Registration fee is 5 dollars which will not include the cost of a banquet ticket or a copy of the *Proceedings* of the Congress.

A World's Fair will be held in New York City during the summer of 1939. Consequently, those who wish to attend the Congress for Microbiology should make plans promptly. The American Express Company, the official travel agency for the Congress, will be glad to assist in such plans.

Scientific workers who wish to register their names as delegates or as contributors of scientific papers are requested to communicate with Dr A. C. Ukil, Secretary, Indian Committee, International Society for Microbiology, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

The effect of antithyrotropic serum on the action of human thyrotropic hormone

The thyrotropic hormone of the anterior lobe of the pituitary gland stimulates the thyroid gland Injection of this hormone leads to symptoms of hyperthyroidism. In Grave's disease it is suggested that this hormone is secreted in enormous quantity. Collip and Anderson (*Lancet*, April 16, 1938) have shown that if injection of thyrotropic hormone into an animal be continued for several weeks a state of resistance is gradually developed and the thyroid gland is no longer influenced by the hormone. If serum from such an animal be injected to a normal animal the latter acquires a passive immunity to the thyrotropic hormone. The serum of the resistant animal possesses strongly antithyrotropic properties. This antithyrotropic serum is species-specific. Antithyrotropic serum derived from ox pituitaries is found to have no therapeutic value in the human subject. It is very difficult to collect human pituitaries for the preparation of antithyrotropic serum.

—*S. Banerjee.*

Hyper-adrenalism and Buerger's Disease

In Buerger's disease there is hyperplasia and degeneration of the middle coat of small arteries together with much proliferation and desquamation of the innercoat. Similar changes are also seen in veins but they are not occluded. It is suggested by Oppel (*Arch. Ital. clin.*, 1937, *47*, 5, 481,) that hyperadrenalism is a possible cause of Buerger's disease as better results are obtained by the excision of suprarenal of one side. Similar changes in the vessels are obtained by transplants of suprarenal tissue in males but less easily in females. Castration in males has no effect but if it is followed by implantations of ovary the arterial changes following the suprarenal grafting are insignificant or absent. This indicates the value of ovarian extracts in the treatment of Buerger's disease.

—*S. Banerjee.*

Vitamin B_1 and Nicotinic Acid in Pellagra

Spies and Aring (*Jour. Amer Med. Ass.*, 1938, April 2, p. 1081) have treated cases of classic pellagra with peripheral neuritis by the administration of vitamin B_1. The neuritic pain is promptly relieved by the intravenous injection of vitamin B_1. Glossitis and stomatitics are however not cured by vitamin B_1. Nicotinic acid cures these conditions. Pellagra is

therefore the result of more than one factor, a conclusion also arrived at by Guha in 1931 (*Brit. Med. Jour.*, 1931, (ii), 53).

—*S. Banerjee.*

Vitamin B_1 in Herpetic Keratitis

According to J. Nitsulescu and E. Triandaf (*Brit. J. Ophthal*, Dec. 1937, 654.) Vitamin B_1 was found to be very useful in two cases of herpetic keratitis. The pain is relieved, progress arrested and cure hastened. There is however no evidence of aritaminosis.

-*S. Banerjee.*

Vitamin C and Blood Sugar Level

G. Izar and G. Cairrone have shown (*Med. Jour.* 8, 1938, p. 5) that subcutaneous injections and per oral administration of vitamin C are found to cause a fall in the blood sugar level in normal as well as in diabetic subjects. The fall reaches its maximum about an hour after the injection and is followed by a progressive rise up to the original level in the next three hours.

- -*S. Banerjee.*

Public Telephone

Independent bacteriologists and employees of Post Office, Medical Departments in England and United States have examined all public telephones. They say that the risk of tuberculosis infection from the use of the telephone is negligible.

Our Medical Article for August

The following article on 'Tuberculosis and Industry' has been contributed by Dr. P. K. Sen of the Department of Tuberculosis Research All India Institute of Hygiene and Public Health, Calcutta for our 'Medicine and Public Health Section' of the present issue of the journal.

Industry and Tuberculosis

P. K. Sen

Department of Tuberculosis Resarch, All India Institute of Hygiene and Public Health, Calcutt.

Tuberculosis has been present among human beings for a very long time. But never before has the disease been so active and wide spread as in this industrial age. We all know tuberculosis spreads by contact, specially from one person to another. Any factor which increases the chances of contact also increases the possibility of more people being affected by this disease. Industry is one of the most potent factors in this direction.

Formerly, people used to be of more rural habits. They lived in villages, there was no congestion; the houses being wide apart, they came in contact with fewer persons. They, in short, lived in a manner which afforded a much better protection from infection from others. With the advent of industrialisation, people from different parts of the country were drawn to areas where factories were located, so that soon there was over-crowding. Besides, being aggregated in small areas, they came to more intimate contact with one another both in the workshops and private lives. The housing problems of the workers, though becoming increasingly important as days passed, were neglected at the beginning. There was no plan for ventilation, no plan to avoid overcrowding. The workers gathered as close as was possible to their working areas. This made the housing and living conditions of the workers extremely poor and insanitary. We are conducting an investigation amongst the workers of a jutemill near Calcutta. The crowding, living conditions and sanitation of the houses where workers live are very unsatisfactory. Most of the workers come for work from the villages. Though poor in their homes the conditions of living are quite different. They are just the people who do not acquire much specific resistance against tuberculosis as the incidence of the disease is much less in rural areas. They are, in the words of Prof. Cummins, " Virgin Soil ".

In the cities where the chances of contact are greater, people are generally infected at a young age. If the infection is not overwhelming, which in most cases is the case, the disease is not established but the person acquires a specific resistance which can cope with, to a large extent, the subsequent infections to produce disease. These village people are generally not infected, that is, they are like " Virgin Soil ". When they come for work in the industrial areas, they fall into this deep mine of insanitary conditions. The insecurity of position, unhealthy social habits, and mental disturbances arising out of this new environment sap out their vitality. Added to these is the greater chance of infection due to over-crowding both at the working places and in houses. A person who was not infected before, if infected with massive dose of bacilli, facilitated by the above conditions, he gets the disease quickly and in a more fulminating form. They die like flies and infect others rapidly and surely because of their ignorance and peculiar living conditions. Borrel, the great French pathologist, first detected this peculiar behaviour of the disease in such uninfected men. The African recruits in the Great War, the Senegalese, came to France. They were farthest away from civilization and tuberculosis amongst them in their native country was rare. They were, therefore, " Virgin Soil ". When they arrived in France, they fell into an atmosphere where moderately heavy infection was possible. The French men are used to this and they do not get the disease. But the Senegalese, as they had no previous infection and consequently acquired resistance. Fell a prey to the disease and they died like flies. Though India and her village people are not in the same category of " Virgin Soil " as the Senegalese, yet certainly they are not as resistant as the Europeans or the town dwellers of India. So, when they come for search of work and have to live in the crowded environment where opportunities of massive infection are more frequently present, it is very likely that many of them get the disease and behave somewhat like the Senegalese.

India is on the road to industrialization. If at this very beginning we take note of the havoc that has been played by tuberculosis in other countries we can minimize much of the sufferings and can save many lives. We must try to improve the housing conditions, give protection by various methods to those who are not infected and remove the diseased persons from amongst the crowds. We do not need the building of expensive houses for workmen. We cannot afford it in this present financial conditions of our country. With the advance of industries we hope to be richer. Then only can we undertake to build houses for workmen as is being done now in Germany and at places in Great Britain. What we want now is good planning for even the *Bustee* or *Kutcha* houses. Much could be achieved by simple planning to minimize crowding and to increase ventilation. To my mind, this should be one of the greatest obligations on the part of the authorities to look after the living conditions of the labourers. This should be done with the inception of the industry in a certain area. Planning from the beginning is important as it is very hard to demolish already built areas and to rebuild them. Besides, once the workers are used to insanitary living, it is very hard to change the ways even if they are housed under better sanitary conditions, later on. But, if they are educated and disciplined in the ways of the living from the very entry in the industrial life they have a much better chance to acquire healthy habits and to live accordingly.

The dangers mentioned above are the general effects of industrialization in a population who are not used to it. But there are some special industries which make the workers particularly susceptible to tuberculosis. All the industries evolving silica dust in their process are dangerous. The chief amongst them are pottery, sandstone, granite, metal grinding, sandblasting, manufacture of scouring powders, gold mining and coal mining. In all the above industries, silica dust is given up in very minute particles. They are inhaled by the workers during the whole period of their work. The inhalation of this dust may cause a disease of the lungs which is known as silicosis or miner's phthisis.

The production of silicosis depends on the nature of dust -its chemical composition, concentration in the working atmosphere and size of the particles and also on the presence of any previous lung-disease of the worker.

Quite an amount of work has been done on the chemical composition of silicious dust to find out the most potent composition in the causation of silicosis. From the result of all the investigations it seems that " free silica " is the most dangerous form of dust to cause silicosis. Silicates are less dangerous though at one time sericite or silicate of aluminium and potassium (K_2SAlO_3 6 SlO_2 $2H_2O$) was thought to be more dangerous than any other form.

Silica dusts are inhaled in the deeper parts of respiratory tract. They are then engulfed by certain

cells coming into the terminal portions of air-passages and carried to the nearest lymphatic. There they lodge and get dissolved in tissue fluid. Silica is an extremely insoluble mineral but investigations of King and Mellor show that it gets dissolved in tissue fluid very slowly. As silica is a tissue poison it causes necrosis of the area where it gets dissolved and there is a surrounding reaction of fibrosis. It is why in silicosis the lungs become beset with nodules of fibrosis. The last International Silicosis Conference came to the conclusion that silicosis is due to "solution" of the silica in tissue fluid. If that is so, it probably is right to say that the form of silica, combined or free, which is most soluble in the tissue fluid is the most dangerous form of dust.

In order to produce silicosis the dust must be present in the atmosphere at a certain concentration. If the dust is diluted with air or by any other medium to a certain extent body can dispose of the dusts and no harmful effect occurs. Cummings thinks that a normal man may work in an atmosphere unimpaired in health if the silica dust does not exceed 5,000,000 particles per cubic foot of air. This is almost the threshold" number of silica dust to produce disease. Any concentration above this forbodes danger and the more the concentration the more is the likelihood to develop the disease and to develop it rapidly.

The size of the particles also plays a great role in the production of the disease. The smaller the particle is, the longer will it float in the air, the easier will it enter into the deeper parts of respiratory tract and the sooner will it get dissolved, as smaller particles expose a greater total surface area of the dust to the action of the plasma. It is generally believed that particles of 5 micron and under in diameter are dangerous. This is known as "Effective size range." Any particle above this range is probably not dangerous enough to be taken into account. In fact most of the particles from the diameter of 10 micron and above cannot even enter the deeper parts of the respiratory tract. They are caught by the cilia of the mucous membrane of the upper air passages and are thrown out. Thus they have no effect.

Once a worker gets silicosis he is almost certain to die of tuberculosis in later years. No definite reason could be given for this susceptibility of the silicotic to tuberculosis. But it has been found to be true. Many authors believe that tuberculosis and silicosis are inseperable conditions, that is, when silicosis is present there is every likelihood of tuberculosis being present too. In my own investigation among the South Wales silicotic-coal-miners, no element of tuberculosis in some of them could be detected even by the most laborious search by clinical and *postmortem* examinations. We may, therefore, believe that though silicosis makes the person very susceptible to tuberculosis, tuberculosis is not universally present amongst the silicotics. But this cannot mitigate the dangers to which workers in all silica industries are exposed.

It will be realized from the names of the industries mentioned that many hundred thousands of workers are working in an atmosphere laden with silica dust. In Europe, America and South Africa a great amount of work has been done on preventive measures. The factories or the mines must be well ventilated, water sprays are used to bring down the dust particles and masks are used. There are many devices for all these preventive measures which are suitable to particular conditions. By these measures they have brought down the number of silicotics. This is a gain not only for the workers but for the capitalists also. For each case of silicosis, by the Compensation Act, the authorities have to pay quite a large sum of money as compensation.

It is unfortunate that almost no work has been done on the 'dusty industries' in India. We have many industries where silica dust is given out in clouds and it is likely that many of the workers are falling a prey to this disease and later to tuberculosis. It is urgent that we should conduct investigations amongst these industries and find out the incidence-rate of this disease and of tuberculosis. If required all the preventive measures must be adopted. The sooner it is done, the better.

The Tuberculosis Enquiry under the Indian Research Fund Association has begun an investigation amongst the Jute workers in a Jute mill in the neighbourhood of Calcutta. Most of the labourers there are recruited from villages. We shall be able to see the effect of this industrialization on the rural people. Besides, jute is a dusty industry and we may be able to find out whether or not there is any dust hazard in this important industry which is a monopoly of Bengal.

Research Notes

New Types of Vitamin-D (D_3 & D_4)

That ergosterol is not the only pro-vitamin D, has definitely been established in recent years (Windaus, Lettre and Schenck. Ann. *520*, 28, 1935; Windaus, Schenck and Werder, *Z. Physiol. Chem. 241*, 100, 1936). It has been found that irradiation of 7- dehydro cholesterol prepared from cholesteryl acetate, gives rise to a substance of high antirachitic activity (24,000 international units per mg. as compared with 40,000 units for vitamin D_2 which is obtained from ergosterol). This variety has been known as vitamin D_3.

A very recent observation by Windaus and Trautumann (*Z. Physiol. Chem., 247*, 185, 1937) has given further proof of the above view. It has been shown that irradiation of 22-dihydro erogosterol yields a substance (m.p. 107-8°, $(\alpha)D^{18}$—89·3) having a high anti-ricket potency and showing an absorption maximum at 265 m μ as shown by vitamin D_2 and D_3. This new variety of ricket-preventing substance has been termed as vitamin D_4.

This development in the line of chemistry of sterols and vitamin D, that sterols irrespective of the molecular weight can be made to possess antirachitic property, will add much towards the progress of science as well as towards the alleviation of human sufferings.

—*M. C. Nath.*

Influence of Heavy Water upon Amylase Formation

Germination of many seeds is associated with marked increase in their amylase activity. This increase is often due to the formation of several starch-splitting enzymes. Malted barley has been found to contain at least two distant amylases in proportions which depend upon the treatment of the grain. As water is an important factor in these changes and is also essential to the action of the amylases after they are formed, it is of special interest, therefore, to study the influence of heavy as compared with ordinary water upon the generation of amylase activity during the sprouting of barely.

Caldwell and Doebbeling (*J. Biol. Chem, 123*, 479, 1938) have performed experiments to compare the amylase activities of barely grains before germination with those of grains which had been allowed to germinate in water and in different concentrations of heavy water. The comparisons were made at definite intervals during the course of germination and also at what appeared to be the same stages of germination of the grains. The concentrations of heavy water studied were 1, 10, 50, 100%.

The authors conclude that heavy water is not appreciably unfavourable to the metabolism of this grain even when present in concentrations many times higher than those which are probably normally encountered in nature.

Hundred per cent heavy water, however, had a markedly unfavourable influence upon the rate and extent of the sprouting of the barley and upon the generation of the amylase activities which is affected in the same direction as the germination of the grain. Moreover, the unfavourable in-influence of the higher concentrations of heavy water was much more pronounced with the starch splitting (a-amylase) than with the sugar forming (B-amylase) activity.

—*H. N. B.*

UNIVERSITY AND ACADEMY NEWS

Royal Asiatic Society of Bengal

An Ordinary Monthly Meeting of the Royal Asiatic Society of Bengal was held on Monday the 4th July, 1938, at 5-30 p.m.

The following candidates were balloted for as Ordinary Members:—

(1) Andrew McLaren Carstairs, M.A., Bengal Chamber of Commerce, Calcutta.

(2) Suprabhat Mozumdar, M.A. (Cal.), Master, Rajkumar College, Raipur, C.P.

The following papers were read: —

(1) Chintaharan Chakravarty.— Kāśīnātha Bhaṭṭa and his works.

A fairly large number of small treatises, principally on Purana or Tantra topics, ascribed to one Kaśīnātha Bhaṭṭa Bhada of Benares, *alias* Śivānandanātha, are available in manuscripts in different parts of India. But very few of these works have been brought to the notice of scholars either through descriptive notes or through print. Little again is known about the author. So an attempt has been made to collect an account of these works as well as of the author so far as could be gathered from a survey of them, mainly on the basis of the manuscripts of a large number of Kāśīnātha's little-known works, belonging to the Royal Asiatic Society of Bengal.

(2) R. Grace Lewison.—Folk-Lore of the Assamese.

A collection of 39 Folk stories, in English translation, collected during the auther's ten years' residence in Assam. Narrator's name given in each case. The stories are classified as historical, moral and amusing.

The following exhibits were shown and commented upon:—

(1) M. Mahfuz-ul Haq.— A note on a Persian Manuscript of Saḥā'if-i-Sharā'if of Muhammad 'Askari-al-Husainī' of Bilgrām.

The manuscript, which comprises the biographical sketches of the Persian prose-writers of India and Irān, has recently been acquired by the Royal Asiatic Society of Bengal.

The manuscript is apparently unique as no other copy is known to exist in any well-known library. A feature of the manuscript is that it is the author's autograph copy.

The author, Saiyyid Muhammad 'Askari bin Saiyyid Khurshīd 'Ali, was born at Bilgram. He was a talented Persian scholar and poet of his age. He composed the Saḥā'if in 1213 A.H. (1815-16 A.D.). It contains valuable data regarding the Persian prose-writers in general and the contemporary Indian writers in particular. There are several interesting specimens of the compositions of the Mughal kings, princes and princesses.

(2) Chintaharan Chakravarty.—Manuscript of a hitherto-unknown work of the *Pārānanda* School.

The only work so far known expounding the doctrines and practices of the little-known but cosmopolitan Pārānanda School of Tantric worship, which puts a taboo on ritualistic details as also on animal sacrifice, which apparently is an essential feature of Sakti-worship, appears to be the *Pārānanda Sūtra*, published in the Gaekwad's Oriental Series (Volume

LVI, Baroda, 1931). The Royal Asiatic Society of Bengal possesses a fragmentary manuscript of a small work, called the *Pārāmānandamatasamgraha*. It gives a brief account of the school. While the printed text, which is diffuse, is at times obscure, the present work, though of small extent, is clear and systematic.

(3) Baini Prashad.—Habitat group of the goggle-eyed fish or mud-skipper *Periophthalmodon schlosseri* (Pallas).

Gobies of the genera *Periophthalmodon* and Periopthalmus represent, in their habits, two of the most terrestrial types among fishes. They frequent the sea shores and estuarine mud-flats of the Indo-Pacific Region, and are sometimes found considerably above the water level, on aerial roots of plants and other objects that may be present in their habitat.

The mud-skippers breathe atmospheric air direct, and their skin is especially modified for conserving moisture. Their eyes are well adapted for a sharp aerial vision, and they use their highly muscular pectoral fins for locomotion on land. They feed on small animals that are left stranded on the mud-flats by the receding tides.

The exhibit shows a portion of the foreshore of Matlah at Port Canning. The dwarf Sundari shrubs (Avicennia officinals L.) with their aerial roots form a characteristic feature of the habitat. The other noteworthy inhabitants of the mud-flats or of the associated saline pools are the Crabs, *Varuna litterata* (Fabricius and *Gelasimus annulipes* Latreille and *molluscs* of the family Cerithiidæ.

National Institute of Sciences of India

An Ordinary General Meeting of the National Institute of Sciences of India was held in the Library Hall of the India Meteorological Department, Poona, on the 25th and 26th July 1938 from 9 a.m. to 11 a.m. and 3 p.m. to 5 p.m. on both the days.

A Symposium on "Weather Prediction" was held, in which the (Abstracts of papers to be read enclosed herein) programme was as follows:

Dr C. W. B. Normand.—Opening remarks.

Long Range Forecast—

Dr S. R. Savur.—Seasonal forecasting in India.

Medium Range Forecasts—

Mr S. Basu.—Franz Baur's forecasts for 10 day periods.

Daily Forecasts—

(1) Air mass analysis and short period weather forecasts—

Dr S. N. Sen.—Air mass analysis and short period weather forecasts.

Dr S. K. Pramanik. Application of air mass analysis to the problem of forecasting of nor' westers in Bengal.

(2) Upper Air Data and Weather Forecasts—

Dr K. R. Ramanathan. Upper air data and weather forecasts.

Dr N. K. Sur.—Latent instability in the atmosphere and its consequences.

Mr S. P. Venkiteswaran.—Rainfall due to winter disturbances and the associated upper air temperatures over Agra.

Dr S. K. Pramanik.—Upper air data and weather forecasts.

(3) Forecasting for aviators—

Mr P. R. Krishna Rao.—Weather forecasting for aviation with special reference to local forecasts.

(4) Kinematical Methods in Weather Forecasting—

Dr S. K. Banerji.—Kinematical methods in weather forecasting.

Book Review

The Metallurgist's Manual, (*Cheap Edition with supplement*) *by T. G. Bamford, M.Sc., and H. Harris, M.Sc., published by Chapman and Hall, Ltd., London, Price 7s-6d.*

This book is intended for the use of metallurigists, metallurgical students at universities and technical schools of engineers and of others interested in metals. In accordance with the object, emphasis has been laid more on the practical aspect of the subject than on the theoretical background. In fact the book is one of the few publications on the essentials of metallurgy. The book is divided into seven chapters; each chapter gives a fairly clear account of the subject included in it. Chapter I deals with sampling and assaying of ores of copper, iron, manganese, gold, silver, platinum and other important metals—their qualitative and quantitative examinations. Chapetr II provides sound methods for the complete analysis of both ferrous and non--ferrous alloys of every day use. Chapter III is devoted entirely to the complete examination of fuels and refractories. Chapter IV shows in a very precise way how to calculate furnace charges—an information which is of fundamental importance to the beginners and workers in the metallurgy. Chapter V gives a clear and complete account of the methods available for the measurement of high temperature and the procedures actually adopted. Chapter VI deals with the practical sides of metallography and industrial alloys, which are very well treated. Chapter VII contains a summary of the manufacture of nonferrous castings.

The tables appended at the end of the book serve a variety of purposes and are seldom found together in any single text book on metallurgy.

The book can be recommended to metallurgists, students of metallurgy and to others interested in metals.

—H. N. D. G.

Television—Theory and Practice—*by J. H. Reyner, B.Sc., A.C.G.I., A.M.I.E.E., Second and Revised Edition.* Chapman and Hall Ltd., London 1937.

We welcome this new edition of the well-known publication by Mr Reyner. The old edition has undergone extensive changes and a large portion of the new edition has practically been re-written. The book is divided into two parts, the first dealing with the receiving technique and the second with the transmitting technique. As stated by the author more stress has been laid on the fundamental principles of the subject—and these have been very lucidly explained—than on the detailed descriptions of actual methods and systems. The serious student of Television going to take up the study of the subject will find the book extremely helpful. An excellent survey of the principles of both transmission and reception, particularly of the modern systems, is given. The treatment is logical and nonmathematical and the author has been able to bring home to the reader that Television to-day has passed the amateurish stage and has attained a sort of stability based on strict scientific principles. Inspite of the opinion expressed by the author that in an art like Television, which is changing so rapidly, detailed description of an actual working apparatus may soon become out of date we would have liked to see such discussion and description of some of the actual modern transmitting and receiving apparatus which are in more or less common use to-day. We hope it may be possible to include this in future editions of the book.

—H. K. R.

BOOK REVIEW

INTERMEDIATE PRACTICAL CHEMISTRY, *by Prof. P. B. Sarkar, D.Sc., Published by H. Chatterjee & Co., 19, Shamacharan De Street, Calcutta. Price 1/4- First Edition, 1938.*

This book is intended to meet the requirements of the Intermediate Students in practical chemistry. It fully covers the syllabus of the Calcutta University and Dacca Intermediate Board. The experiments have been very carefully drawn up and the description is very lucid and clear. The book seems fairly thorough and systematic, and the subject-matter has been well-arranged. The Intermediate students in science will have to appear at the practical examination from this session; and it is quite in the fitness of things that the author produced a really good book for the students. His book has been a distinct improvement upon the existing ones on the same subject and the students are sure to be benefited by this timely publication.

Besides the practical details, the book contains a world of useful information put in a popular way. This will go a long way to create a taste for chemistry for the beginner. The book is well bound but the printing leaves much to be desired.

—P. K. D.

LAC CULTIVATION IN INDIA, *by P. M. Glover, B.Sc., Indian Lac Research Institute, Namkum, Ranchi, Bihar, India, 1937. Price Rs. 2/-.*

This is a practical manual of lac cultivation which is one of India's present day monopoly trades. This book deals with the entomological study of lac insects with their geographical distributions in various parts of the world. A statistical report is given about the increased production of lac grown in India, Burma, Bangkok and Singapore. Detailed methods which have been worked out at Namkum to combat lac pests, which are the chief destroyers of lac insects, are discussed. The different soil treatments with manures and fertilizers for the improved growth of lac hosts thus causing increased production of lac are described. This book is intended to give the necessary information regarding lac cultivation in India and is likely to be much valued by educated lac cultivators and owners for the improvement of lac production. This book may be recommended to all concerned.

Baidyanath Ghosh.

ANNUAL REVIEW OF BIOCHEMICAL AND ALLIED RESEARCH IN INDIA, *Vol. VIII. Published by the Society of Biological Chemists, India, Bangalore. Price Rs. 3 or sh. 6.*

The latest volume of the series has come to be regarded as a stock-taking of the progress of biochemistry and allied researches in India during the year 1937. This review deals in a nut-shell with all the contributions which workers in India and Indian research workers abroad have made to the advancement of biochemical knowledge during the last year. The different chapters include -Vitamins, Proteins, Enzymes, Pharmacology, Human physiology, Pathology and Bacteriology, Food and Nutrition, Microbiology and Fermentation, Plant Physiology, Chemistry of plant products, Phytopathology-Mycology, Phytopathology-Entomology, Soils, Fertilizers and Manures, Animal Nutrition and Dairy Science, Veterinary Science--which are written by specialists in their respective fields.

This Review can be confidently recommended to all, who wish to have a connected impression of the biochemical contributors by Indian workers. The presentation and printing are excellent and the book is remarkably free errors. There is a full bibliography with each chapter.

Baidyanath Ghosh.

Letters to the Editor

[The Editor is not responsible for the views expressed in the letters.]

Epidemic Dropsy and the Contact Infection Theory

In the investigations of Lal, Ray and Ghosal[1] on epidemic dropsy it has been stated that "as the number of rooms per person increases, the incidence (of epidemic dropsy) also rises, a finding which goes against the contagion theory," (p. 209). As this statement appeared to be *prima facie* very peculiar it was considered worth while to go into the statistical analysis employed which could lead to such a conclusion. It is difficult to imagine a disease whose incidence will increase with the decrease in congestion.

A scrutiny of the statistical analysis indicates that it is based on faulty methods. The analysis suffers from the following two errors:—

(1) The partial correlation, the interpretation of which leads to the above conclusion, has been calculated *according to a wrong method*.

(2) No test has been applied to judge the significance of the partial correlation, which alone could have justified the above statement.

In working out a partial correlation same number of observations must be taken for all the variables and the same set of values for each variable must be used throughout. Neither of these conditions is fulfilled in the above analysis. The variables are—incidence, rooms per person and size of the family, the last variable being the one to be eliminated. The number of pairs of observation is 30 in one case and 16 in the other two cases. Moreover, the values of two of the variables, namely, incidence and rooms per person, have been found by one method in the first case and by an entirely different method in the other two cases. Thus the value obtained for the partial correlation is not a valid estimate nor does it enable us to apply any test of significance.

The correct value of the partial correlation, which can be obtained from the two tables containing 16 pairs of observations each, works out to be +0·3983 which is practically the same as obtained by the authors themselves, namely, +0·3976. This is merely a coincidence and should not be taken as a justification of the faulty method. Only 13 degrees of freedom are available for the correct value and Fisher's table[2] gives the expected 5% value as 0·5139, which shows that the partial correlation is not significant. Hence the statement quoted above is not justified. All we can say is that the evidence in hand does not contradict the hypothesis that for a family of a given size the incidence of epidemic dropsy is independent of the rooms per person.

12-B, Bakul Bagan Row,
Bhowanipore, Calcutta.
20-6-1938.

B. Chatterjee.

[1] Lal, Roy and Ghosal, *Ind. Jour. Med. Res.*, *15*, 1, 163-259, 1937.

[2] Fisher, *Statistical Methods for Research Workers*, 4th ed., 188, 1932.

Efficiency of the "Entoray" Mosquito-Catching Machine

The inventor of the "Entoray" machine claims that if the machine is installed in a place it will catch most of the mosquitoes of the place and thereby reduce the incidence of mosquitoes in the surrounding areas within a specified radius. Senior White[1] *et al* have tested the efficiency of the machine and one of their conclusions is that "it is not capable of making any statistically significant difference in mosquito incidence even within a few feet of its point of operation," (p. 629).

A scrutiny of the data and the statistical analysis thereof shows that the experiment was not designed properly and the methods employed in the analysis suffer from serious defects. The following table gives the total hand catches of male mosquitoes for five consecutive years in experiment III (A).

Experimental Area		*Control Area*	
1-22 wks.	23-30 wks.	1-22 wks.	23-30 wks.
346	271	326	269
105	193	92	64
99	99	41	45
82	163	55	80
67	82	81	46

If we compare the figures of 1-22 weeks for the two areas, when no machine was working in either area, it will be seen that while the incidence of mosquitoes was steadily falling in the experimental area, in the control area the incidence was rising since the fourth year. Moreover, in the fifth year the total catch in the control area rose for 1-22 weeks and fell for 23-30 weeks. This shows that some unknown cause has been operating in the control area which was probably

absent in the experimental area. As the actual experiment with "Entoray" was carried out in the fifth year, the value of the second area as a control is extremely doubtful.

Figures for 30 weeks for each of the five years were used in the statistical analysis which was carried out separately for the male and the female mosquitoes. Expected weekly values for the fifth year were obtained by extrapolating from straight lines fitted to four figures for each week. Deviations of the expected from the observed values in the fifth year were worked out. The mean of these deviations for the first period, namely, 1-22 weeks when the machine was not working, was compared with the mean for the second period, namely, 23-30 weeks when the machine was working. Fisher's t test[2] was applied to test the significance of the difference between the means of the two periods. The results of this test could not bring out any significant difference caused by the machine.

The above method of analysis is faulty for the following reason:—

No test has been applied in order to judge the significance of the straight line regressions. As a matter of fact, excepting a very few, the regressions are all insignificant even at the 5% level. Hence there is no justification for working out the expected values from the straight lines.

As anti-larval measures over a wide area were started only from the second year, the best procedure under the circumstances is to take the mean of the values of the second, third and fourth years as the expected value for the fifth year. As the incidence of mosquito during the earlier weeks is rather small, it is better to leave out the figures for first few weeks. This will ensure homogeneity of the figures for each period. In the following table the non-machine period has been taken both as 1-22 weeks and 16 to 22 weeks (the figure 16 has been taken arbitrarily).

	Male.			Female.		
	1-22 wks.	16-22 wks.	23-30 wks.	1-22 wks.	16-22 wks.	23-30 wks.
Mean dev. (Exp.-Ob.) .	1·3	2·8	8·7	2·7	9·7	17·2
Difference . .	7·4	5·9		14·5	7·5	
Standard error	1·41	2·36		2·88	3·86	
Degrees of freedom . .	28	13		28	13	
t . . .	5·23	2·50		5·03	1·94	

Comparing these observed values of t with those expected by chance alone, as given by Fisher,[2] we find that the results are highly significant for both males and females, if 1-22 weeks be taken as the non-machine period. If, however, we take 16-22 weeks as the non-machine period, moderately significant result is obtained in the case of males and no significance is brought out in the case of females. Hence, on the whole it will be safe to say that the machine has reduced the incidence of male mosquitoes, while its effect on the female mosquitoes is doubtful.

In the analysis of figures of experiment III (B) also a faulty method has been adopted. In obtaining the values of χ^2 mean frequencies have been used which is fundamentally wrong. Only total frequencies should be used in χ^2 test. The correct values of χ^2 are highly significant with a positive correlation in the case of males and a negative correlation in the case of females. Thus in the case of males the machine appears to increase the incidence and in the case of females the machine decreases the incidence. The second result is definitely in favour of the machine but the first seems to be somewhat improbable. The figures for the males suggest that the control area is under some unknown influence which probably is absent in the experimental area. Thus the figures for the control area do not provide us with good control figures for the males at least.

We are, therefore, led to the following conclusions:—

(1) The experiments were not properly planned;

(2) Defective statistical methods were applied in analysing the data which led to some positive statement against the machine.

(3) A proper analysis of the data establishes the efficiency of the machine at least in some cases.

12-B, Bakul Bagan Row,
Bhowanipore, Calcutta.
20-6-1938.

B. Chatterjee.

[1] Senior White, Lal, Adhikari, Swaroop—*Rec. Mal. Surv. Ind.*, *6*, 595-629, 1936.

[2] Fisher, *Statistical Methods for Research Workers*, 4th ed., 151, 1932.

Resistivity of Thin films: Caesium

In the last issue of this journal[1] an expression for the dependence of electrical resistivity on the thickness of metallic films was derived on the assumption that electrons colliding with either boundary suffer random scattering, and the formula obtained, *e.g.*,

$$\rho_t = \frac{\rho_\infty}{1 - f(t/\lambda)} \qquad (1)$$

where ρ_t is the resistivity for thickness t,
ρ_∞ „ „ „ bulk material
λ „ electronic mean free path in bulk material

and $$f(t/\lambda) = \int_0^1 e^{-(t/\lambda z)} dz$$

was applied to Lovell's[2] measurements of Rb films. It is proposed to apply the same to Lovell and Appleyards'[3] measurements on Cs films. The following table presents the observed, as well as the calculated values of ρ_t.

$T = 64°K$, $\lambda = 1450Å$

t in A	5	10	15	20	30	40	50	75	100	200	300	400	500	∞
$\rho_t \times 10^6 \Omega$ (expt.)	246·9	140·7	87·9	46·9	24·7	17·3	15·0	13·8	11·8	10·8	9·9	9·9	9·4	4·0
$\rho_t \times 10^6 \Omega$ (Lovell's formula)	172·8	98·7	69·1	54·3	39·5	32·1	27·1	18·7	15·8	8·8	6·9	5·9	5·9	
$\rho_t \times 10^6 \Omega$ (formula 1)	210·0	105·3	76·3	60·6	44·7	36·0	30·3	22·6	18·6	11·7	9·2	7·8	7·1	

It would appear from the table that ρ_t tends to remain constant beyond 300 A, but actually it decreases very slowly and an accurate estimate of its value after 300 A was not possible from the graph in Lovell and Appleyards' paper. It will be observed that formula (1) fits in with the observed data rather well except for the intermediate region 20 to 100 A where the discrepancy between the observed and calculated values is quite as pronounced as rather more so than, in case of Lovell's formula. It is of particular interest to note in this connection that recently Fuchs[4] has worked out an elaborate expression to account for the increased resistivity of films. He has considered cases of random scattering as well as those of partially elastic scattering with different reflection coefficients. Comparing his results for random scattering with ours, we find that according to him also, for values of $t <$ 15 or 20 A, the assumption of random scattering suffices to bring about satisfactory agreement with the observed data. As thicknesses exceed some 200 A°, Fuchs concludes that surfaces again increasingly favour random scattering. For the intermediate region 20 to 200 A° choosing suitable values of reflection coefficients i.e., different degrees of elastic scattering, he obtains as close agreement with observation as desired, though it must be remarked that it is somewhat peculiar that colliding electrons at the surface will behave one way when the film is either very thin or thick and another way for intermediate regions.

Further details will be published elsewhere.

Indian Association for the Cultivation of Science,
210, Bowbazar Street,
Calcutta.
10-7-38.

B. Mukhopadhyay.

[1] *Science and Culture*, May 1938, p. 626.
[2] A. C. B. Lovell, *Proc. Roy. Soc.* A 157, p. 311.
[3] Appleyard, E. T. S., and Lovell, A. C. B., *Proc. Roy. Soc.* A Vol. 158, p. 718.
[4] Fuchs, K., *Proc. Camb. Phil. Soc.*, 34, p. 100, 1938.

The Structure of Sulphur Particles in Colloidal Suspension in Water

It has been reported[1] previously that the spontaneous solid deposits of colloidal sulphur, formed as a result of a very slow process of sedimentation, as well as the electrolytic deposit obtained on addition of a requisite quantity of NH_4OH of proper concentration to the colloidal solution are crystalline and their structures are exactly similar to that of orthorhombic sulphur or S_α.

In order to arrive at a definite conclusion about the real nature of the colloidal sulphur particles in the state of suspension several attempts were made also to study the solution by X-ray diffraction method,[2] but they were all unsuccessful.[3]

Recently we have been able to come to a very definite conclusion as regards the nature of colloidal sulphur particles suspended in water. A totally new method of studying less volatile liquids by the X ray diffraction method has been developed, which involves in exposing the liquid in small drops to the incident radiation. With the arrangements made, it was possible to control the size of drops, which in our experiment was of the order of a millimeter. We found that in the case of colloidal solution of sulphur, a drop of the above-mentioned size remained, on an average, undisturbed and practically unchanged for more than half an-hour inspite of the mechanical disturbances due to the constant working of the pumps and other sources.

It is also worth mentioning here that no change in the quality of the solution was noticed and we have also not been able to observe any trace of coagulation of sulphur particles and the consequent quick deposition of sediments in the colloidal solution under the influence of X rays. To test this point a set of preliminary experiments were necessary. For, if the deposition of sulphur takes place in this condition, any crystalline pattern obtained may be due to these deposits and no definite conclusion regarding the nature of the suspended sulphur particle may be arrived at.

A quantity of the solution was enclosed in a thin-walled glass tube of about 1·5 mm. bore. The tube was sealed at both ends and exposed to the X-rays (5m. amp at 35 K.V.) for about 10 hours. No sign of sedimentation or any other change could be detected.

The photographs obtained with colloidal sulphur drops exhibited a crystalline pattern but the back ground was very diffuse owing to the scattering of X-rays by the water molecules in the solution. Measurements of the sharp rings and the visual estimation of the relative intensities definitely show that the colloidal particles in the state of suspension are

also crystalline like ordinary S_α. The detailed description of the method and the result will be published in the *Indian Journal of Physics*.

Khaira Laboratory of Physics,
University College of Science,
Calcutta.
20-6-38.

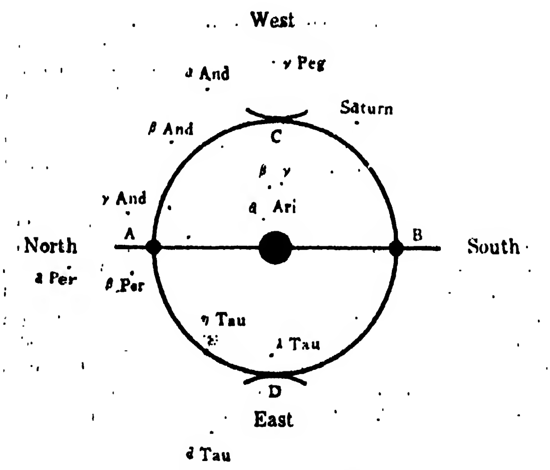
S. R. Das.
K. Ghosh.

[1] *Ind. Jour. Phys.*, July. 1938.

A Lunar Halo with Partial Parhelic Circle and 'Horizontal' Arcs seen at Hyderabad

At about 4 A.M. of 24th June 1938, I witnessed what was undoubtedly an incomplete system of lunar halos, with parhelic circle and so-called 'horizontal' arcs—a phenomenon visible generally in very high latitudes. A rough sketch of the apparition giving the position of the moon in the eastern sky is enclosed herewith.

The first inner halo circle of *white* colour and about 22½° radius was complete; the parhelic circle passing through the moon and the points A, B, extended a couple of degrees beyond its points of intersection with the halo. Its portion inside the halo was faint, and at the points A, B, it presented the appearance of somewhat roundish bright patches.



There was *no* second halo circle of 45° radius, nor was there any semblance of the so-called 'vertical' line passing through the moon, at right angles to the parhelic circle. But at C—the topmost point of the halo, there was a short bright (the so-called 'horizontal') tangential arc, concave upwards, towards the west.

By 4·30 A.M. the lower (eastern) part of the halo was well above the horizon. At D its lowest point, a short, fairly bright (the so-called 'horizontal') arc, slightly concave downwards (towards the east), was discernible.

All the time the sky was covered with a uniform, thin veil of haze. After 4·30 A.M., the southern part of the haze thickened into clouds, the bright spot at B disappeared and the whole system vanished not long afterwards.

On the evening of the 22nd June, there was a good downpour of rain and the night of the 23rd was cold and chilly. The haze on the morning of the 24th was presumably due to minute snow crystals in the upper atmosphere, which gave rise to the unusual halo.

Begumpet, a suburb of Hyderabad, Deccan, has latitude 17° 25′ 54″ North and altitude 554 metres.

Begumpet,
Deccan, N. S. R.
10-7-38.

Mohd. A. R. Khan

The Separation of Neurotoxin from the Crude Cobra (Naja Naja) Venom

Starting with a sample of crude cobra venom the m.l.d. of which for pigeons (300 g) was 0·3 mg. it has been shown by us[1] that the neurotoxin could be concentrated in a protein fraction which constitutes only 5·2 per cent of the protein content of the crude venom, or 1 mg. of the purified product contained 59·6 m.l.d.

Recently we have obtained a sample of cobra (Naja Naja) venom which is three times more active than the venom which we used previously. Experiments were therefore undertaken to separate the neurotoxin from this active sample.

A one per cent venom solution is first precipitated at 22 per cent sodium sulphate concentration as mentioned previously (*loc.cit*). The filtrate then precipitated at 29 per cent sodium sulphate concentration by the addition of more 44 per cent sodium sulphate solution. The mixture is filtered and the filtrate is treated with more solid sodium sulphate so as to bring the concentration of the salt to 36 per cent. The precipitate formed is separated by filtration. The active principle in the filtrate is precipitated by sodium tungstate and sulphuric acid and eluted as described in a previous paper by Ghosh and De.[2] In this way a sample was obtained in which 1 mg. of protein was associated with 106 m.l.d. When, to 8·5 mg. of this product, dissolved in 4 c.c. of ice-cold water, adjusted to pH 2·8, 8 c.c. of ice-cold methyl alcohol is added a precipitate is formed.

This precipitate containing the active principle is separated by centrifuging and then washed with cold 66 per cent methyl alcohol. It is found that 424 m.l.d. are associated with one mg. of protein of this precipitate. The purified neurotoxin sample which we obtained previously starting with a crude venom sample (m.l.d. 0·3 mg.) contained only

59·6 m.l.d. per mg. of protein. Therefore our new preparation is 2·06 times more active than the one reported previously.

Applied Chemistry Department, University College of Science, Calcutta.
B. N. Ghosh.
S. S. De.
N. L. Kundu.

8-7-38.

[1] *Science and Culture*, 2, 585, 1937.
[2] *Ind. Jour. Med. Res.*, 25, 3, 1938.

Note on the use of Mercury volume-meter for the determination of Specific Gravity of Timbers

The methods usually employed in determining the volume of a small specimen of timber are

(1) by measuring dimensions of the specimen and then calculating its cubic content;

(2) by displacement of water;

(3) by displacement of mercury;

(4) by displacement of any other liquid of known specific gravity.

Of these the first method is very simple and direct; and a number of measurements are needed for accurate results. The second method is widely used, but it must be emphasized that the timber specimen in this case is always associated with a certain amount of moisture absorption, and a consequent discrepancy in the results. The method is particularly useless at different stages of progressive drying. The practice of coating specimens with paraffin involves further error in more than one way.

Of instruments depending on the use of mercury, the Breuil mercury volume-meter is very popular. The instrument is so designed that it records the volume in cubic centimeters, and the specific gravity is computed from

$\frac{W}{V \times d}$, where W=weight of the specimen in air,

V=volume recorded by the volume-meter,

d=density of water at the temperature of the experiment.

This method apparently looks very simple. But the trouble with this method is that it is not at all easy to recover all the mercury that penetrates into the timber pores. There is always left some amount of mercury inside the specimen, a matter which should not be overlooked. Besides, as a result of some mercury filling pores, the reading recorded by the volume-meter cannot give a correct value for the amount of mercury displaced. Consequently, a correction must be made to the above formula in order to arrive at a true value of the specific gravity of the specimen under examination, and the following formula was found to be best suited for the purpose—

$$\text{Specific gravity} = \frac{W_1}{V + \dfrac{(W_2 - W_1)}{\text{density of mercury at the temp. of exp.}}} \bigg/ \text{density of water at the temp. of exp.}$$

where W_1=weight of specimen in air,

V =volume recorded by volume-meter,

W_2=weight of specimen in air after mercury displacement.

The Robertson-Brown displacement bottle also makes use of mercury, but was found to be not so accurate as the Breuil volume-meter when worked out as above.

Very little work has been done to determine the specific gravity of timbers by the displacement of some other liquid of knwon density. The results are likely to be affected because of the absorption of liquid by the wood, or the solvent action of the liquid on the ingredients of the timber, or both.

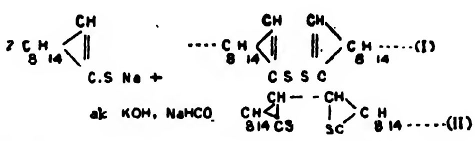
All-India Institute of Hygiene & Public Health, Calcutta.
B. N. Mitra.

14-4-38.

On a New Rearrangement in the Thiocamphor Series

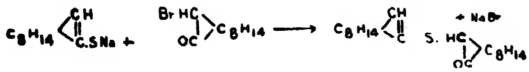
By the action of iodine on sodiothiocamphor in benzene, two products are obtained,—an unsaturated disulphide (I) b.p. 160°/10 m.m., and an 1:4 dithioketone, bisthiocamphor (II) m.p. 180°. The compound (I) is obtained if the reaction is allowed to take place at 0°, and the product is isolated at once from the reaction mixture. But if iodine is added to sodiothiocamphor in boiling benzene, and the product isolated after 15-16 hours, bisthiocamphor (II) results.

The disulphide (I) does not react with hydroxylamine, but gives tests of unsaturation, whereas the dithioketone (II) gives a dioxime and an azine, thus confirming the presence of two—C:S—groups. The disulphide (I) when kept in cold for 2-3 days in contact with alcoholic potash (20%) is changed into the dithioketone (II). The same rearrangement is also effected by heating the disulphide with a saturated solution of sodium bicarbonate or even with a saturated solution of sodium thiosulphate for 5-6 hours. The reaction of iodine on sodiothiocamphor can therefore be represented as follows:—

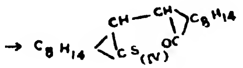


That sodiothiocamphor reacts in the thiolic phase during the formation of bisthiocamphor is also corroborated by the

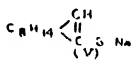
isolation of a sulphide, (III) by the interaction of α-Bromocamphor and sodiothiocamphor according to the following reaction:



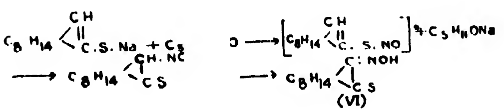
Had sodiothiocamphor reacted in the thioketo phase then thioketone (IV) would have been expected.



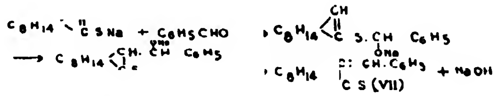
While the paper on bisthiocamphor was published[1] the author explained the reaction by the assumption of a C-Na-thiocamphor analogous to C-Na-Camphor. But the above observation leaves no doubt as regards the constitution of sodiothiocamphor as well as the mechanism involved in the formation of bisthiocamphor. Attempts were also made to isolate C-alkyl-and C-acyl derivatives of thiocamphor, but it has been observed that S-alkyl and S-acyl derivatives are exclusively formed by the action of alkyl iodides and acyl chlorides respectively on sodiothiocamphor. It has also been observed that α-halogenated esters, *e.g.* Bromoacetic ester, α-Brom propionic ester, Bromo malonic ester etc., give rise to S-substituted derivatives with sodiothiocamphor. It is therefore definitely established that sodiothiocamphor unlike sodiocamphor behaves only in one phase and its constitution can be represented by (V).



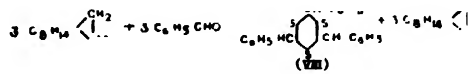
According to this assumption, the formation of all the C-substituted derivatives of thiocamphor can be ascribed to a rearrangement of radicals from sulphur to carbon through the unstable intermediates which could not be isolated. The formation of iso-Nitroso thiocamphor[2] (VI) accordingly, is now represented as follows:—



The formation of Benzylidene derivatives[3] (VII) of thiocamphor by the action of benzaldehyde on sodiothiocamphor can be interpreted as follows:—



Alkali appears to be responsible for the above type of rearrangement, for if the condensation of aldehydes and thiocamphor be allowed to take place in presence of alcoholic hydrochloric acid, the reaction takes a different course with exchange of radicals, camphor and trithio benzaldehyde (VIII) m.p. 226° being the products of reaction:



The exchange of oxygen for sulphur in benzaldehyde is nothing unusual and has also been observed by Mitra,[4] in the case of thioacetoacetic ester.

My sincere thanks are due to Dr P. K. Bose for his kind interest in this investigation and also for the facilities of his laboratory.

The details of these results will be published in due course in the *Journal of the Indian Chemical Society.*

Chemistry Department,
University College of Science and Technology,
Calcutta.
21-6-38.

Dines Chandra Sen.

[1] Sen, *J. Ind. Chem. Soc.*, *14*, 213, 1937.
[2] *Ibid.*, *12*, 751, 1935.
[3] *Ibid.*, *13*, 523, 1936.
[4] Mitra, *J. Ind. Chem. Soc.*, *9*, 633, 1932.

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SCIENCE AND CULTURE

SEPTEMBER 1938
VOL. IV NO. 3

A Monthly Journal of Natural and Cultural Sciences

(2)

IMPORTANT ARTICLES IN THIS ISSUE

Congress President on National Reconstruction.

Development of Electrical Power in U. P.

Technical Assistance to Indian Industry by the Government of India.

Studies in Indian Snake Venoms.

Manufacture of Synthetic Ammonia.

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Vol. IV No. 3
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SCIENCE AND CULTURE

Published under the Auspices of

THE INDIAN SCIENCE NEWS ASSOCIATION

SEPTEMBER 1938

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All LETTERS TO THE EDITOR must reach the office by the 10th of the month previous to the one in the issue of which they are meant to be published.

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UNIVERSITY COLLEGE OF SCIENCE
92, Upper Circular Road,
CALCUTTA

SCIENCE AND CULTURE

SEPTEMBER 1938

VOL. IV NO. 3.

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The Congress President on National Reconstruction

ELSEWHERE in this issue, we publish a momentous pronouncement by Mr Subhas Chandra Bose, President of the Indian National Congress, on the National Reconstruction of India. The Congress President advocates, in unequivocal terms, for a large scale industrialisation of the country, as the only sure remedy for solving the problems of poverty, unemployment and defence. He also outlines a clear-cut scheme for large scale industrialisation. When the National Government comes, says Mr Bose, it should adopt a policy of development of the mother industries *viz.*, of power supply, production of metals, of tools and machineries, and of essential chemicals and of materials essential for transport and communication. It should also train up the necessary technical staff, and set up a National Research Council. Mr Bose suggests that a National Planning Board, composed of eminent scientists, industrialists, and public men should be set up immediately to draw up detailed schemes of promotion of mother industries.

We believe that the President has given the much wanted lead to the country and his advice should be accepted by the Conference of Industry Ministers of the Congress Provinces which is shortly going to meet under his Presidency at Bombay. We hope further that the conference would not break up after merely passing pious resolutions, but should actually bring into existence the National Planning Board to draw up a detailed report on large scale industrialisation. This report, which we think will take from about six months to a year to take shape, will serve as a guide not only to the Congress Provinces but also to others, and the Central Government. We hope that the Report will create a clarity of vision and a correct definition of ideal, point out the true path, and thus remove the embarassing confusion of thought now prevailing all round the country.

The magnitude of the confusion of thought and its paralysing action is not, we are afraid, properly realized. We take only one example, the Industries Minister of one Congress Province expressed recently his determination to effect largescale industrialisation, but a little later in his speech, we were dismayed to find out that by largescale industrialisation, he means cardboard manufacture and soap-making. He did not probably realize that these are very minor industries, and their introduction and success as well as those of many others depends on cheap supply of power, of essential chemicals, and of raw materials; if supplies of these are ensured, the minor industries would grow spontaneously without any state effort. To use a metaphor, the ministers are not attending to the root and stem of the tree but to the foliage. They forget that if the root is properly watered, the foliage will take care of itself. But at the present times, the Government exercise no substantial control over these key (or mother) industries and have

allowed them to fall under private hands. At any moment, these small scale industries where they exist may be killed by corporations which control the mother industries. Further, these ministers, being new to their task, and being unable to obtain the necessary technical advice from their subordinates, have not been able to obtain the proper perspective with respect to industrialisation. The confusion is further accentuated by uncritical newspaper propaganda, and by the patting-on-the-back-of such propagandists by highly placed persons. Mr Bose has very pointedly exposed the hollowness of the claims of a director of industries who, having introduced, according to his own version, a cheap method of manufacturing umbrella handles, and bell-metal goods, tried to create the impression that he has brought on industrial regeneration for the province. We are afraid that he is not the only specimen of his class.

In strange contrast to the clarity and boldness Mr Bose's pronouncement is the official policy of industrialisation, or tinkering with industrialisation which is exposed in another article in this journal "Technical Aid to Industries by the Government of India." This will convince all readers that the men who have been so long responsible for the administration of India want Indians to grow nothing but 'potatoes and tobacco.' Strangely enough, they are supported, though not orally, but by their action, by the extreme section of the Congress who advocate a return to the primitive forms of life—to the bullock cart, spinning wheel, and the home-spun.

We hope that Mr Bose's pronouncement will create the proper perspective, and if it is further backed by the report of the National Planning Commission, will chalk out the proper line of action. Let us also hope that the pronouncement will cut the Indian Nation adrift from the philosophy of the bullock-cart to which it has so long been tethered, on account of an incorrect appreciation of the importance of industries to the Nation.

We do not minimise the evils that have crept into the modern capitalistic-cum-scientific world. But these evils have arisen, because man has gained considerable control over forces of nature before he has gained moral control over his own self. The developing miracle of science is at our disposal to use or to abuse. But what should not be forgotten is the fundamental fact, that if popular leaders and popular governments are as intelligent and far-sighted as Mr Bose, if business men are more disinterested, and if we all work for social welfare and social justice, we can, with the aid of science, enter into an era of plenty and prosperity; where every man and woman in India can live in comfort which would have been the envy of Emperor Shahjehan. Biologically speaking, life is a continuous process of adjustment and the tempo of modern scientific progress demands that the rate of such adjustment should be very considerably accelerated in India. The tradition should disappear that each generation should live more or less under conditions which governed the lives of its fathers and should transmit to the next generation similar conditions of living. We wish to hold up before every inteligent man and woman in this country this vision of new adjustment. Such a psychological change alone will give us the strength to overcome the enormous difficulties that beset our path in the evolution of the Indian Nation.

Address of the Congress President—Mr Subhas Chandra Bose

I AM deeply grateful to you for the honour you have done me by inviting me to the annual meeting of the Indian Science News Association, which is responsible for publishing the well-known scientific journal, "Science and Culture." You can imagine my feelings in the midst of such a highly intellectual and cultured audience. But though I feel utterly ignorant and small in such a company, I welcome the occasion for more reasons than one. In the first place, I have a very high appreciation of this valuable work that is being done by SCIENCE AND CULTURE. Secondly, it is a privilege to meet such distinguished scientists and have an opportunity of exchanging ideas with them. Thirdly, it affords me some relief from the monotony and drudgery of my daily life and enables me to breathe a healthy, intellectual atmosphere though for a short while. Last but not the least, I am greatly interested, as all of you undoubtedly are, in the application of science to the problems of national reconstruction.

The movement for Indian emancipation has reached a stage when Swaraj is no longer a dream —no longer an ideal to be attained in the distant future. On the contrary, we are within sight of power. Seven out of eleven provinces of British India are now under Congress Ministries. Limited though the powers of those governments are, they have yet to handle the problems of reconstruction within their respective domain. How are we to solve these problems? We want, first and foremost, the aid of science in this task.

The Congress and the Task of National Reconstruction

I have always held the view and I said so in my presidential speech at the Haripura Congress, that the party that fights for freedom cannot liquidate itself when power is won. That party should face the task of post-war reconstruction as well. Hence, Congressmen of to-day have not only to strive for liberty, but they have also to devote a portion of their thought and energy to problems of national reconstruction. And national reconstruction will be possible only with the aid of science and our scientists.

The President is wholeheartedly for Large-scale Industrialisation

May I now, with your permission, place before you some of my ideas on the problems of national reconstruction? We hear very often now-a-days of schemes for bringing about industrial recovery in this land. An officer in this province recently wrote a voluminous book on a recovery plan for Bengal. Problem we have to face is not industrial recovery, however, but industrialisation. India is still in the pre-industrial stage of evolution. No industrial advancement is possible until we first pass through the throes of an industrial revolution. Whether we like it or not, we have to reconcile ourselves to the fact that the present epoch is the industrial epoch in modern history. There is no escape from the industrial revolution. We can at best determine whether this revolution, that is industrialisation will be a comparatively gradual one, as in Great Britain, or a forced march as in Soviet Russia. *I am afraid that it has to be a forced march in this country.*

The Need of a National Planning Commission

I have no doubt that when we have a national government for the whole country, one of the first things we shall have to do is to appoint a National Planning Commission for the whole country. As a matter of fact our ministries in the seven provinces have already been feeling the need of a uniform industrial policy and programme. Anticipating this, the Congress Working Committee passed a resolution a year ago, soon after the Congress ministries came into existence to the effect that it was necessary to appoint a committee of experts to

advise the Congress Governments on industrial matters. This view was confirmed by the Congress Premiers' Conference which met in May, 1938, in Bombay under my Chairmanship. Thereafter, the appointment of the Committee of Experts has been before the Working Committee and at its last meeting in July, the Working Committee decided that as a preliminary step, I shall convene a conference of the Industries Ministers of seven Congress-administered provinces. I am stating all these facts to show that without waiting for the advent of Purna Swaraj, we are moving in the direction of economic planning.

Though I do not rule out Cottage Industries and though I hold that every attempt should be made to preserve and also revive Cottage Industries wherever possible, *I maintain that economic planning for India should mean largely planning for the industrialisation of India.* And industrialisation, as you will all agree, does not mean the promotion of industries for manufacturing umbrella-handles and bell-metal plates, as Sir John Anderson would have us believe.

I gratefully recognise the fact that your magazine SCIENCE AND CULTURE has helped to direct intelligent thoughts in this country towards the problems of industrialisation. The articles published periodically on Electric Power Supply, Flood-control, River-physics, Need of establishing a National Research Council etc. have been highly illuminating and instructive.

Principles of National Planning Outlined

I should now like to make a few observations on the principles of National Planning.

1. Though from the industrial point of view the world is one unit, we should nevertheless aim at national autarchy, especially in the field of our principal needs and requirements.

2. We should adopt a policy, aiming at the growth and development of the mother industries *viz.*, power-supply, metal production, machine and tools manufacture, manufacture of essential chemicals, transport and communication industries etc.

3. We should also tackle the problem of technical education and technical research. So far as technical education is concerned, as in the case of Japanese students, our students should be sent abroad for training in accordance with a clear and definite plan so that as soon as they return home, they may proceed straightway to build up new industries.

So far as technical research is concerned, we shall all agree that it should be freed from governmental control of every kind. It is only in this unfortunate country that government servants are entrusted with scientific research on receipt of princely salaries and we know very well what results have been obtained therefrom.

4. There should be a permanent National Research Council.

5. Lastly, as a preliminary step towards national planning, there should be an economic *survey of the present industrial position with a view to securing the necessary data for the National Planning Commission.*

These are, in brief, some of my ideas on the problems of industrialisation and national reconstruction and I believe they are held in common by scientific men and women in this country. We, who are practical politicians, need help from you, who are scientists, in the shape of ideas. We can, in our turn, help to propagate these ideas and when the citadel of power is finally captured, can help to translate these ideas into reality. What is wanted is far-reaching co-operation between Science and Politics.

Divergence of Views in Congress Ranks

Prof. Saha has in the course of his illuminating address, asked me what the attitude of the Congress is towards the problem of industrialisation. I must say that all Congressmen do not hold the same view on this question. Nevertheless, I may say without any exaggeration that the rising generation are in favour of industrialisation and for several reasons. Firstly, industrialisation is necessary for solving the problem of unemployment. Though scientific agriculture will increase the production of the land, if food is to be given to every man and woman, a good portion of the population will have to be transfered from land to industry. Secondly, the rising generation are now thinking in terms of Socialism as the basis of national reconstruction and Socialism

presupposes industrialisation. Thirdly, industrialisation is necessary if we have to compete with foreign industries. Lastly, industrialisation is necessary for improving the standard of living of the people at large.

Question of Fundamental Unity of India

Prof. Saha has asked another question *viz.*, whether India will be one nation when she is freed from British control. To this I may reply that we of the Congress are conscious of our responsibility in the matter of achieving Indian unity and solidarity. We want to go, not the way of China but the way of Turkey. But we shall have to work very hard indeed, if we want to hold together as one nation when we are free. For promoting national unity and solidarity, many things are needed *viz.*, a common lingua franca, a common dress, a common diet etc. The Congress, as you are aware, has been advocating Hindustani as the lingua franca of this country. But I believe that what is wanted most of all is the will to be one nation and to hold together as one nation, when foreign domination ceases. Thus, to my mind, the problem of unity is largely a psychological problem. The people must be educated and drilled to feel that they are one nation. Other factors, like language, dress, food etc. may help unity, but cannot create it. In addition to this national will, what is needed for maintaining national unity and solidarity is an all-India party. That party is the Congress. We find in history that each country has produced a party for the purpose of unifying the people of that country. The Communist Party in Russia, the Nazi Party in Germany, the Fascist Party in Italy, Kamal's Party in Turkey are instances in point. The Congress Party in India will play the unifying role which the above parties have played in their respective countries.

Let me, in conclusion, thank you once again for inviting me to this function this evening. May "Science and Culture" have a long useful and prosperous career in the service of the nation and humanity and may the generous public come forward enthusiastically to support this venture by enlisting as subscribers, by making liberal donation and in other ways.*

* Delivered on the occasion of the Anniversary Meeting of the Indian Science News Association, 1938.

A Chinese Philosopher on Principles of Education

A country's education is in principle the same as an individual's. A father or elder brother in arranging their son's or younger brother's education determines his approach according to whether he is to be a scholar, farmer, artisan, or merchant.... If he is to make baskets, they will not teach him something else....So with a country and its public education. The education is the means by which it nurtures its own kind of people, welding them together as a whole that they may be independent and struggle to survive in this world where victory goes to the fit and defeat to the unfit. To achieve this end is impossible with daubs of easternism and westernism, to-day learning some foreign language, to-morrow establishing some special study, in slipshod confused fashion hoping to reap the fruits. Those who have a mind to this great business of education must first recognise the two principles of education, the one the tool for manufacturing the people of the country, the other an indispensable means for understanding the world's experience, for examining the tendencies all over the world and the special characteristics of our own race with a view to arousing its whole strength.

Liang Ch'i-Ch'ao.

The Development of Electrical Power in the United Provinces

A. N. Tandon
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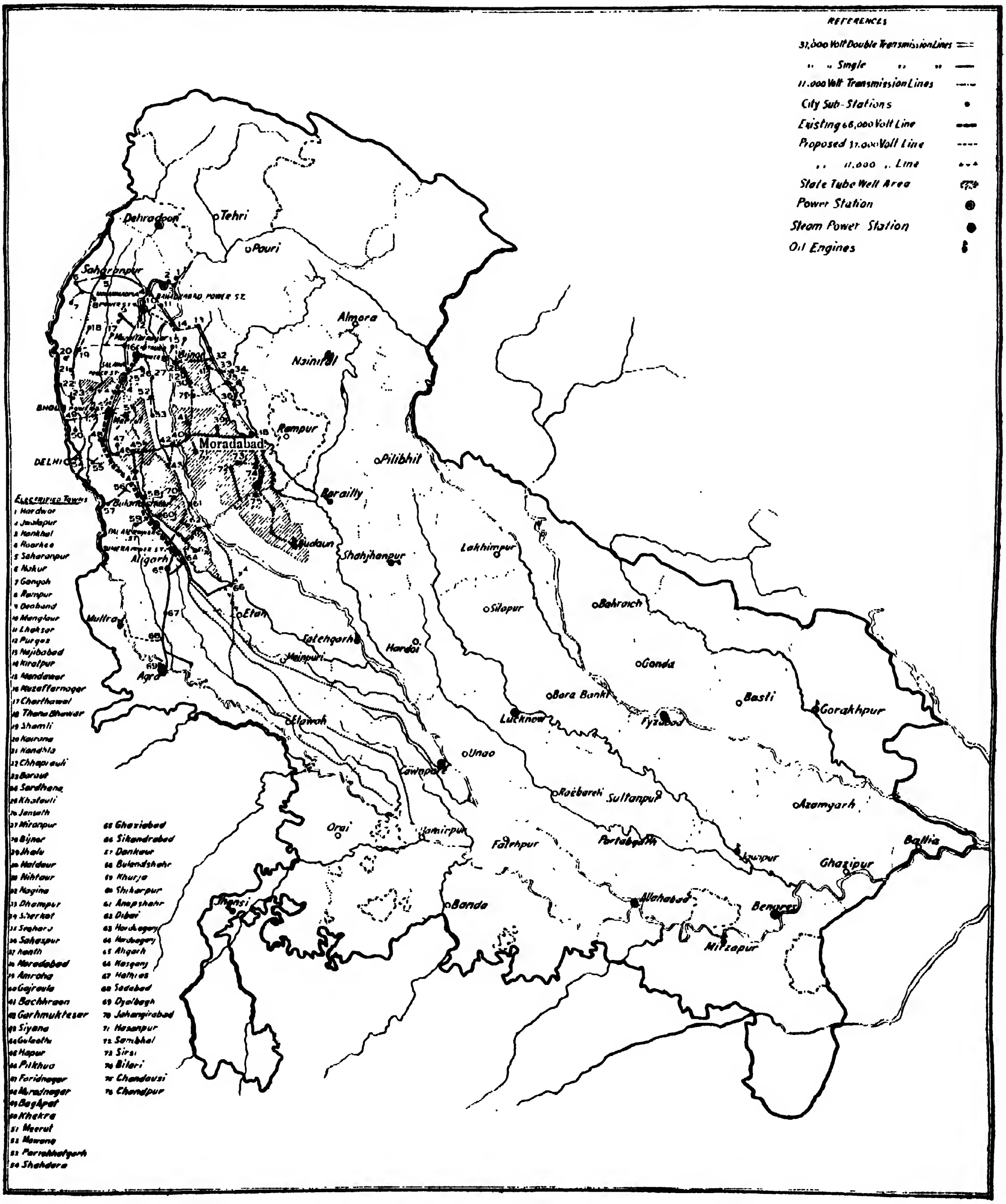
THE development of electrical power is a very important problem, and every country in the present state of economic struggle has to give the fullest attention to it. As a matter of fact, the degree of civilization of a country is now measured by the quantity of power a large part of which is bound to be electrical which it produces.. Electrical power is now-a-days consumed for industrial purposes, for domestic use (lights, fans, and heating) for traction (electric trains) and for agriculture. The figures for all the prosperous and independent countries have shown that the industries alone consume the major part of the total power supply (more than 80%).

It is, therefore, evident that the question of development of industries is closely linked up with the problem of cheap power supply. This is all the more important for the development of small-scale cottage industries, which can never prosper without a cheap supply of electricity. I can cite here the example of Japan where more than 50% of the industrial output is from cottage industries, but these cottage industries are not worked by primitive machinery and manual labour, but by the up-to-date machinery. The use of up-to-date machinery is possible when the State has assured cheap supply of electrical power. Electrical power has superseded all other forms of powers as it has some advantages not possessed by others. It is, therefore, no wonder that the attention of the public of our province has been drawn to the problem of cheap generation and distribution of electricity. The Government of the United Provinces has recently appointed a committee to investigate into a few aspects of this problem dealing mainly with the question of tariffs, but it is regrettable that the questionnaire issued by them shows a woeful bankruptcy of ideas on the part of the mentors of Government. The questionnaire shows that the mentors want the attention of the public to be diverted, to use a figurative language, to the foliage of a tree and not to its root. What is wanted is a thorough examination of the question of generation and supply from the national point of view.

The present state of electrical supply in the province is hopelessly antiquated. It looks upon electricity as an article of luxury, and the supplies in the big cities have been entrusted to electric supply companies on terms, which are extremely unfair to public interests, and retard the growth of industries.

The public supply of electricity in this province probably begins from 1915, and a few years ago it was confined to a few big cities like Cawnpore, Lucknow, Allahabad, Agra, Benares and Gorakhpur. These cities have still got their old supply companies. Besides the above-mentioned cities electricity is also supplied in some district head-quarters by oil engine plants (capacity 250 kw—1000 kw). With the exception of Cawnpore, the consumption of electricity in most of the cities is confined to domestic use (light and fan), municipal supply, i.e., (street lighting and power for water works) and for small plants like flour mill, etc. With the inauguration of the Ganges Canal hydro-electric project, the idea of rural electrification has also been introduced and in several western districts of the province many small towns having populations of about 5000 and over have been supplied with electricity. The present state of electrification is shown in the map on the next page.

No reliable estimate of the total installed power in these provinces is available but my estimate is that at present the total capacity installed in the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33,000 Volt Double Transmission Lines
" " Single " "
11,000 Volt Transmission Lines
City Sub-Stations
Existing 66,000 Volt Line
Proposed 33,000 Volt Line
" 11,000 " Line
State Tube Well Area
Power Station
Steam Power Station
Oil Engines
Dehradun
Tehri
Pauri
Saharanpur
Almora
Naini Tal
Rampur
Moradabad
DELHI
Pilibhit
Bareilly
Budaun
Shahjahanpur
Lakhimpur
Bulandshahr
Aligarh
Muttra
Agra
Etah
Fatehgarh
Hardoi
Mainpuri
Sitapur
Bahraich
Gonda
Bara Banki
Basti
Gorakhpur
Lucknow
Fyzabad
Etawah
Unao
Cawnpore
Raebareli
Sultanpur
Azamgarh
Orai
Hamirpur
Fatehpur
Partabgarh
Jaunpur
Ballia
Ghazipur
Jhansi
Banda
Allahabad
Benares
Mirzapur
ELECTRIFIED TOWNS
1 Hardwar
2 Jwalapur
3 Kankhal
4 Roorkee
5 Saharanpur
6 Nakur
7 Gangoh
8 Rampur
9 Deoband
10 Manglaur
11 Lhaksar
12 Purqaz
13 Najibabad
14 Kiratpur
15 Mandawar
16 Muzaffarnagar
17 Charthawal
18 Thana Bhawan
19 Shamli
20 Kairana
21 Kandhla
22 Chhaprauli
23 Baraut
24 Sardhana
25 Khatauli
26 Jansath
27 Miranpur
28 Bijnor
29 Jhalu
30 Haldaur
31 Nihtaur
32 Nagina
33 Dhampur
34 Sherkot
35 Seohara
36 Sahaspur
37 Kanth
38 Moradabad
39 Amroha
40 Gajraula
41 Bachhraon
42 Garhmukteser
43 Siyana
44 Gulaothi
45 Hapur
46 Pilkhua
47 Faridnagar
48 Muradnagar
49 Bagpat
50 Khekra
51 Meerut
52 Mawana
53 Parikshatgarh
54 Shahdara
55 Ghaziabad
56 Sikandrabad
57 Dankaur
58 Bulandshahr
59 Khurja
60 Shikarpur
61 Anupshahr
62 Dibai
63 Harduaganj
64 Harduaganj
65 Aligarh
66 Kasganj
67 Hathras
68 Sadabad
69 Dyalbagh
70 Jahangirabad
71 Hasanpur
72 Sambhal
73 Sirsi
74 Bilari
75 Chandausi
76 Chandpur

province is about 65000 kw. including small oil engine plants and the hydroelectric power. The total consumption per year cannot exceed 200 million units and the consumption per head of population is approximately 4 units per year. Even in Japan where the natural power resources are not so plentiful, the consumption per head is about 400 units per year. This shows the backwardness of a major province of India in the matter of electricity supply.

Out of the total installed power, 29000 kw. are installed in the Ganges Canal hydroelectric grid. I shall, therefore, proceed to describe this grid system in detail.

The water of the Ganges canal in its course from Hardwar to the plains passes over 12 falls, which range in height from 7 to 10 ft. Most of these falls are situated between Hardwar and Meerut, and one is situated at Sumera near Aligarh. The Government of the United Provinces, under the persuasion of the chief engineer of Irrigation, Sir William Stampe, decided in 1926 to obtain electrical power from these falls and the present grid system is an outcome of that scheme. It has been developed in these stages, the details of which can be read in an article by Sir William Stampe published as a supplement of the *Leader* dated November 4. At the present time electricity is generated at seven falls and the capacity installed of the stations is as follows:—

Bahadurabad and Salempur (4×600+2×1000)	..	4,400 kw.
Mohammadpur (2×2000)	..	4,000 „
Chitaura (2×1500) ..	..	3,000 „
Salawa (2×1500) ..	..	3,000 „
Bhola (4×375) 1929 .. (2×600) 1934	..	2,700 „
Palra (3×200) ..	..	600 „
Sumera (2×600) ..	..	1,200 „
Total	..	18,900 „

Besides these, there are stand-by steam plants at Chandausi having an installed capacity of 9000 kw. and several other small oil engine generators (total capacity 1885 kw.) at Moradabad (500 kw.), Saharanpur (250), Meerut (250), Tundla (200), Aligarh (200), and Lhaksar (75). These stand-by stations are meant to supply electricity when the water supply in the river becomes insufficient during the dry season. It will be noticed that their capacity exceeds one-third of the total power developed by the grid.

All the above plants which are situated at fairly large distances are interconnected by high voltage transmission lines. These lines are shown in the map. Out of the total generating capacity of 28,900 kw. roughly 24,000 kw. are available for consumption at 1600 sub-stations on the system.

The Capital Costs

The total cost of the system is given as Rs. 348 lakhs inclusive of all overhead charges. Out of this 127 lakhs have been spent for generation, 160 lakhs on transmission lines alone and 61 lakhs for transformers and switch gears, etc. The capital cost, therefore, comes to Rs. 1,204 per kilowatt installed. For the sake of comparison I give below the capital cost of other hydroelectric plants working in India.

		Rs.
Tata Power Co., Ltd. ..	..	550
The Andhra Valley Power Supply Co.	..	708
Tata Hydroelectric Power Supply Co.	..	566
The Cauvery scheme ..	..	550
The Mundi Hydro-electric Works	..	3,844

It is, therefore, evident that next to the Mundi scheme which holds the World's record in costliness, the present one has been the costliest. We, therefore, cannot congratulate the sponsors of the scheme on having achieved anything to *cheap* generation of electricity.

The cost of generation of the unit of energy is about 10·4 pies and the Irrigation Department expects that by 1940 41 this cost would come down to 8·95 pies (*i.e.*, ·74 annas). The cost of generation per unit in the case of other hydroelectric works is much less; in the case of the Cauvery scheme it is 3 pies (*i.e.*, $\frac{25}{100}$ annas).

Let us now turn to the rates charged by the grid supply. There are

(1) For Agricultural purposes.	1 anna per unit.
(2) All units in excess of 1200 per B.H.P. year	8 pies ($\frac{66}{100}$ anna) less 2 pies for payment within the scheduled time.

(3) For industrial use.	At 1 anna 6 pies per unit subject to the sliding scale of rates.
	For the first 1320 units -/1/6
	Up to 1200 units after the 1320 units -/0/9
	Next 900 -/0/7
	Remainder -/0/2½.
(4) For domestic use.	At 6 annas per unit with a discount of 6 ps. per unit for payment within 21 days of presenting the bill.

It may be mentioned here that the rate at which water is supplied to the cultivators is even higher than the existing canal rates.

It is evident from what has been quoted above that the Ganges Canal hydroelectric scheme has been conceived on an extremely uneconomic basis. The high capital cost is partly due to the fact that the whole load has been distributed over a very large area (about 4,000 miles of transmission lines) and a disproportionately high cost has been incurred in distribution. The initial objects that have led to the construction of such a long transmission system have been

(1) to electrify 88 towns most of which have a population of less than 20,000,

(2) to supply power for pumping water for canal irrigation in the case of Ramganga and Kali Naddi Rivers,

(3) to work the tube-well irrigation scheme, and

(4) to exercise agricultura machinery on private farms.

The load distribution has been de as follows:-

Industrial	10,500 kw.
Agricultural	3.400 „
State Tube-Wells	10,970 „
Domestic	2,900 „

Much has been made of supply of electricity for agricultural power, for raising water from wells. It is well known that the agricultural load is required spasmodically for only a few months in the year. This has, therefore, substantially reduced the yearly load factor with subsequent increase in the generation cost. The first principles of economics therefore tell us that electrical power is unsuitable for agricultural purposes. One can convince himself if one finds out what percentage of total power is used for agricultural purpose in any other country. In Russia it is less than 2%. In China where in certain places fields have to be irrigated from deep wells, as in Western U.P., pumps driven by oil engines and mounted on motor trucks are in use. If the Government is anxious to promote well-irrigation, it appears that the grid system would be terribly expensive for on the average only 100 watts are consumed per mile. The best solution appears to be motorized pumps, motive power being obtained from petrol or alcohol engines.

It has been calculated that even at the present load factor, the cost price per unit at the generating station is only three pies. I can, therefore, only conclude that the supply would have been cheaper if instead of trying to capture the public imagination by the idea of rural electrification, the sponsors of the grid system concentrated on the load in a small area round the generating station. It may be argued that the power which is generated is much larger than required for these regions but the map of U.P. clearly shows that practically all the generating stations have a moderately big city within ten miles from it, thus, for example, the station Bahadurabad is near Hardwar, Chitura and Salawa near Muzaffarnagar, Bhola near Meerut and Sumera near Aligarh. These cities alone can easily consume all the power if it is really supplied at a cheap rate. It has been argued that on account of the absence of any mineral area in the vicinity of the generating stations there was no possibility of any development near the generating station but chemical industries, and other industries which depend most on electrical power could flourish easily if power was available at a much cheaper rate.*

Let us now turn to the steam-driven plants in our province and to the possibility of a scheme of electrification by installation of stations run by long-haul coal. We have, at present, steam-driven generators in all the big and important towns of

* It is not quite true that there are no minerals in the region referred to. There are deposits of bauxite, and copper, and others, but probably their economic posibilities have not been explored—*Editor.*

the province. These stations are run by Electric Supply Companies which have got licences from the Government and have powers vested in them by the Electricity Supply Act of 1910. It is difficult to know the exact cost of generation from the supply companies, as most of them treat this as a business secret. We can, however, easily calculate the cost price of a unit of electricity from a station run by long-haul coal from the fields of Bihar or Bengal. The price per unit will depend upon (1) the capital costs including distribution, (2) the fuel cost, and (3) the load factor. I, therefore, proceed to examine the items separately.

The cost of merely installing a Kilowatt for a moderately sized station is about Rs 200/-. We can suppose on the average that Rs 250/- will be spent on distribution, *i.e.*, making a capital cost of Rs 450/- per kw. It is easy to get money at 4% interest and if we keep 5% for depreciation and 3% for maintenance and repairs, a sum of 12% per year is needed on the capital invested. A kilowatt installed produces 8760 units of energy per year but all of it can only be consumed in an ideal case. Generally only 40% is available. The overhead charges per unit therefore come to

$$(450 \times 12 \div 100) \times (100 \div 8760) \times (16 \div 40)$$

$$= 24 \div 100 \text{ annas}$$

(2) The cost of fuel depends upon the distance from the coal fields. As an upper limit for the most western districts we can take the price per ton to be Rs. 20/- for our province. Now, we know that only 1.5 lbs. of coal* are needed to produce 1 unit of electricity. The price of fuel per unit, therefore, comes to 21/100 annas, making a total cost of 45/100 annas per unit for the western districts. (For the eastern districts Benares for example, the cost cannot exceed $\frac{30}{100}$ annas). This price for western districts as evident is almost half the cost price per unit of the Hydro-electric Grid electricity.

* This is an average figure for Great Britain. Some of the most efficient steam plants consume even less than a pound of coal for generating one unit.

The present situation of the supply of electricity energy in one province is therefore wholly unsatisfactory. There is one more project known as the 'Eastern grid and pumping project' which is under the examination of the Government. In this scheme the object of the government is to generate 7700 kw. from a fall of River Tons near Rewa (state), and to supply it for pumping water to irrigate some parts of the districts of Allahabad, Mirzapur, Partabgarh and Benares. The price as estimated is Rs. 880/- per kilowatt which is rather large and it is doubtful if the estimate would remain even this after the completion of the scheme.

In view, therefore, of the present unsatisfactory condition of the supply of power I venture to make the following suggestions:—

(1) That a power research board be appointed in this province to study in detail about the question of power generation and supply in this province and to formulate measures by which the generation of electricity may be done by the state on the lines of Soviet Russia and Great Britain.

(2) The Government should also investigate into the methods by which proper co-ordination between industry and electrification be established. No scheme of electrification can function well without proper co-ordination with industries.

(3) In order to encourge the development of rationalized cottage industries the government should establish model industries in important places in the electrified area, and should offer co-operation and advice to anybody who wants to run a cottage industry.

(4) Before launching any scheme the government should see that the proper material and technical staff is readily available in the country. If proper persons are not available batches of young men should be sent to foreign countries to learn the technique of electricity generation and distribution.

Technical Assistance to Indian Industry by the Government of India

THE question of technical aid to Indian industries by the Government has been before the latter and the public ever since the later half of the last century. After the disastrous famine of 1877-78 the Government of India appointed a Famine Commission to enquire into the causes and consequences of famines. Amongst their principal recommendations may be mentioned the following:—

(1) In treating of the improvement of agriculture....the more scientific methods of Europe may be brought into practical operation in India by the help of specially trained experts, and the same general system may be applied with success both to the actual operations of agriculture and to the preparation of the market of the raw agricultural staples of the country. There does not appear any reason why action of this sort should stop at agricultural produce and should not be extended to the manufactures which India now produces on a small scale or in a crude form, and which with some improvement might be expected to find enlarged sales, or could take the place of similar articles now imported from foreign countries.

(2) The Government might further often afford valuable and legitimate assistance to private persons desiring to embark in a new local industry, or to develop or improve one already existing, by obtaining needful information from other countries or skilled workmen or supervision and at the outset supplying such aid at the public cost.

Unwillingness of the Government of India to promote Industrialisation

The report of the Famine Commission was published in 1880 and it clearly recognized that the poverty problem in India could not be solved by improvements in agriculture alone, but by a simultaneous improvement of the industries, which was equally necessary. In spite of the report and popular clamour, little heed has been so far paid to its most important recommendations. The Indian National Congress came into existence in 1885 and since its third session it has been off and on urging the Government for spread of technical education and encouragement of Indian industries. Since 1905, an Indian Industrial Conference had met for a number of years as an adjunct to the Indian National Congress and has repeatedly urged for measures for the encouragement of indigenous industries. But neither have the recommendations of the Indian Famine Commission nor the representations of the Indian National Congress nor those of the Indian Industrial Conferences produced any appreciable effect on the policy of the Government of India.

Lessons of the Great War

The outbreak of the Great War in 1914 drew forcible attention to the extent of India's dependence upon countries outside the British Empire for the supply of the many of the necessities of life for her people. It may be recalled that during the War, supplies of dyes, important chemicals, many important medicines were almost completely stopped and prices of textiles soared so high that poor people had to fall back upon old rags. The transport service was completely disorganized as almost all railway materials had to be imported from foreign countries, mainly England. The Government of

TECHNICAL ASSISTANCE TO INDIAN INDUSTRY BY THE GOVERNMENT OF INDIA

India felt the necessity for a change in its industrial policy. In 1915, under the stress of war, the Government of India addressed the Secretary of State as follows:

> "After the War, India will consider herself entitled to demand the utmost help which her Government can afford to enable her to take her place, so far as circumstances permit, a manufacturing country."

This policy was nominally accepted by the Secretary of State for India and the Indian Industrial Commission, under the chairmanship of Sir Thomas Holland, was appointed in 1916 to consider and report in what ways this help can be given. The Commission formulated a comprehensive scheme for State co-operation in industrial advance. A subsidiary committee to the Commision was formed under the chairmanship of Prof. Thorpe of the Imperial College of Science, London, to consider the technical work for the scheme of state co-operation formulated by the Industrial Commission. The establishment of an All-India Chemical Service was recommended to exploit the chemical resources of India. The public grew suspicious that the department would be completely dominated by service rules, and non-Indian experts. Sir P. C. Ray, who was a member of Thorpe Committee, wrote a strong note of dissent against the institution of a Chemical Service not based on professional efficiency and in his presidential address to the Indian Science Congress held at Nagpur in 1918, strongly pleaded for the Indianization of Indian scientific services. Public conscience was roused, and nothing further was heard about the institution of a Chemical Service.

A Mountain in Labour

The net result of the negotiations between the Secretary of State and the Government of India and of the labours of the Industrial Commission was the birth of another bureaucratic department—that of the Imperial Department of Industries—a veritable mountain in labour. This Department apparently considered its task finished after it had organized a Stores Purchase Department. As far as we are aware, the departments of Industries have done nothing to promote any of the ***major industries of India.*** All this has been characteristic of a Government by civilians, which takes its orders from a Government 6,000 miles away, and is not responsible to the people for its actions.

How the Lessons of War were forgotten

The Industries Conference at which the centre and provinces took counsel ended with the fourth conference in 1922; the two held after the introduction of Montagne-Chelmsford reforms had shown clearly that the provinces, arguing as Pandit Madan Mohan Malaviya did in his note of dissent to the report of Industrial Commission and as Sir P. C. Ray had also said, did not desire to see the establishment of any central scientific services. The Department of Industries of the Government of India was replaced by a ***Department of Industries and Labour,*** which had an even smaller share in the industrial policy than its predecessor. No action whatsoever was taken to give effect to the recommendations of the Industrial Commission which aimed at producing technical improvement of industries and their assistance in other ways. By 1923 the lessons of the Great War had been completely forgotten.

The Industrial Research Bureau

As a result of the Imperial Conference in 1926, the subject of Industrial Research came once more to the forefront and representation was made in 1928 to the Government of India by the provincial governments about the necessity of co-ordination of industrial research work in India *and of the establishment of an Imperial Council of Industrial and Scientific Research on the lines of Imperial Council of Agricultural Research. The central government, however, shelved the matter on the ground of financial stringency.* At the fifth Industries Conference held in 1933, after a lapse of eleven years, it was agreed unanimously that a central co-ordinating authority should be set up for the co-ordination of industrial research, and, in 1934, the Government of India, being no longer able to avoid the question, set up an Industrial Research Bureau, attached to the Indian Stores Department with an Advisory Council, composed of representatives of the central and provincial governments with

a few non-official members. A research branch was created at Government Test House, Alipore, Calcutta, to do research work on problems recommended by the Advisory Council.

Needs of the Country

National research requires national planning. If research is to be directed along the most useful lines, it is just as important for a nation as for a private firm to decide what it wishes to make and place on the market. It is clear also that any system of organized research must take into consideration the economic structure of the country. Indian industries are now and will be in future, chiefly based on the raw materials available in the country, but much still requires to be done for their development. The most prominent deficiency and most promising field is in connection with research work on the raw materials which are vegetable products. In the case of minerals good work has been done by the Geological Survey of India and our information regarding the mineral resources of the country has reached a relatively satisfactory stage. In the case of vegetable products, however, which occur in enormous quantities and in great variety, comparatively little work has been done of the kind necessary to translate the purely scientific (which, too, is extremely meagre) into a form suitable for the investing industrialist. It has to be ensured that the samples examined are representative, they must represent the plant at its best, the material must occur in quantities that would permit of economic assembly at a suitable place of manufacture and the accessory conditions ought to be such as to justify capital outlay. It has to be recorded to our shame that no such systematic work has been hitherto done, and the examination of little data that does exist concerning any product of probable commercial value generally brings into noticeable relief our ignorance of the very facts that are necessary for satisfactory industrial enterprise. Hardly any serious attempt was done to push the utilization of raw materials. For most industries, it is not the chief raw material that gives the wise investor anxiety as the accessories. The expert prospector of one substance may find his favourable results of no use without favourable results of a wholly different class. For, general industrial progress the manufactures of India must be in a position to make use of the results of work done elsewhere, but to apply them to local conditions is seldom easy. In some instances, the information available is designedly left incomplete and gaps have to be filled in by trials and experiments whilst the adaptation of methods and processes to Indian conditions and to Indian materials often involve in research work of a complex and difficult character. Between the first stage of the inception of an industrial undertaking and its actual realization there is usually a necessity for scientific and expert control. As the Industrial Commission observes,

> "Much money in the past would have been saved if the importance of these preliminary investigations had been realized. Ordinarily, no firm can afford to risk the cost of employing the various experts so required in an uncertain venture. This is more appropriately the business of the State and the survey of its natural resources should be undertaken systematically, not in the form of an isolated series of special prospecting tests, which results in frequent repetitions, with wasteful overlapping of results and embarassing gaps."

Need for Power Survey and Research Institute

A special survey of the coal situation in India should be undertaken with a view to introducing economy in the methods of mining and consumption. Such a review of the fuel situation should include an examination of the measures in progress for rendering more accessible the undeveloped fields. The advantages in using wood fuel after conversion into gas should be investigated, particularly those in employing charcoal for the production of gas after the removal of the by-products which are of value for industrial purposes. France, which has no liquid fuel, but plenty of wood, has worked out a method of converting wood to liquid fuel and has shown that it is economic. Possible sources of industrial alcohol should be investigated. A liberal policy should be followed by the excise authorities when commercial requirements conflict with excise regulations. The utilization of water power is of the highest importance in view of the necessity of creating electrochemical and thermoelectric industries and of economizing the use of coal. An organization

should at once be created to carry out a systematic survey of the hydro-electric possibilities.

New Industries

At present there are many industrial enterprizes which can be started by the importation of machinery and experts provided sufficient protection is given against foreign competition. A recent illustration is offered by the sugar industry. Here *we have mostly to imitate and not much to initiate.* It was the adoption of such a course that enabled Germany, Japan and United States of America to achieve rapid industrial development. On the whole the best way for starting selected industries in India and for training the future managers is, after the fashion of Germany, Japan, Russia and other countries, for the promoters to draw liberally on Great Britain, etc., for real experts; then to select young men, already trained in technological institutions or working in similar industries, who have shown an aptitude to grasp new methods, and to put them through close disciplined industrial and business training under these experts and in industries of the foreign countries. It should be made a condition with the foreign industries supplying stores to India that they will have to afford facilities to Indians for such a training. Further, no foreigner should be imported into India unless he is a recognized expert in his particular line. He, too, should be engaged on a short-time contract and made to understand that he is being engaged and paid to teach our local men just as much as to introduce and carry on his work. The young man from abroad who is educated but inexperienced should not be brought to India and allowed to get his practice here. We shall later on refer to the machinery needed to achieve these objects.

Organization of Technological Institutes

The necessity of having good technological institutions for the training of workers for the factories and for producing future leaders of the industries has been thoroughly made out by the Industrial Commission. Its importance is realized by the Government. Several technological institutes, which have been established in this country, have, however, not lived up to the hopes they created. The reason for this failure has been two-fold. Firstly, there has not been any definite policy in their working. They have been controlled by civilian administrators and very often the scientific officers of the institutes themselves have been absolutely out of touch with real industrialists and scientists. Such a condition is conducive to vegetation. Secondly, proper care has not been exercised in selecting the right type of men to be in charge of them, although there had never been a dearth of such people in this country. The quality of students entering them was also not good as there were hardly any prospects for them after having received their training. Technological institutes and industries are complementary phases, one stands and works for the other. In the absence of any serious efforts to create and expand Indian industries, the products of technological institutes have to rust in enforced idleness as there are no employments for them. If these institutes are really to be of any use it is necessary that they should be properly staffed and properly supervised and efforts be made to attract good students whose services should be utilized after training.

Need for Industrial Museums and Demonstration Farms

A good deal of attention has been given to the Government demonstrational factories by the Industrial Commission. Their need seems to be felt in the case of cottage industries. Such factories as those of sugar do not serve any purpose. The one defect with them was that the officials in charge did not exert themselves in attracting industrialits and businessmen and the public in general to inspect them and be thereby benefited.

Need for Industrial Research

It is impossible to solve the problems of poverty and unemployment in this country and to lay the foundations of healthier cultural life without a large-scale industrialization of the country. At present all the civilized countries have developed their industries to such an extent that in order to compete with them in her own markets India must make the best use of her resources and her industries should be most efficient. It is science that will help her to

do this. This is in a sense a scientific age where there is an ever increasing recognition throughout the world of the importance of science to national development. A number of great nations are now expending large sums of money in financing scientific and industrial research with a view to using their natural resources to the best of advantages. Much attention is also paid to the improvement of industrial processes and also to conducting researches in pure science which it is hoped may ultimately lead to the rise of new industries. The need for such research is all the more important in the case of India, a country where it has been persistently neglected.

The cost of supporting research cannot indeed be justified by comparing it with the prime cost of production, especially when demands are falling off, but by the consideration that it is the means of improving and cheapening production and, in consequence, of increasing the demand. Research is a cost in the same category as insurance. It is an insurance against the effects of ignorance with the certainty, if it is wisely undertaken, of large and continuous bonuses.

What is Industrial Research?

To understand the nature of research work needed for the industrial uplift of this country, and to infer from that the kind of worker needed by us, we cannot but quote from the report of the Committee of the Privy Council for Scientific and Industrial Research, England (1921-22, pp. 30, 31).

"We have laid some stress on the importance of fundamental research as compared with the work directed to the removal of immediate and practical difficulties. There is indeed little basic difference between the fundamental research work required by industry and academic scientific research sometimes styled 'Pure research.' Real difference is of stimulus. The general tendency in pure research is to follow the train of thought of greatest scientific interest by pursuing the problem initially selected through all the ramifications which may present themselves or at least through all those which interest the investigator. The phenomenon investigated and the taste of the research worker are in most cases the only directive forces. In industrial research, on the other hand, the aim is more definitely objective; the work has a distinct purpose in view which the investigator must constantly bear in mind. He cannot afford to follow attractive bypaths unless he believes that they will lead him to a relevant destination. The problems of industry draw attention to gaps in scientific knowledge which it is essentially the duty of the industrial researcher to fill. The acquisition of such knowledge may be called fundamental research as applied to industry."

"We have been led to make these observations because we have found some evidence recently of a good deal of misconception in the distinction popularly drawn between industrial and pure research. There is undoubtedly some ground for this attitude in the loose use by industrialists and company promoters of the word research to describe experiment by trial and error and in the attempts often made to solve complex problems connected with industry on the full scale without any adequate preparations for the passage from the laboratory to the works. The wise manufacturer knows better than this and the man of science supports him. But we maintain that the distinction between fundamental industrial research and pure research lies primarily in the source from which the impulse to its conduct is derived. We desire rather to emphasize the essential unity of all research; its stimulus may come from different sources; its application may be various, but its outlook, its spirit, its methods are one."

What makes a real Research Worker?

From the above we can infer the type of research worker we need. To borrow the words of the Late Lord Rutherford, the President of the Advisory Council of the Department of Scientific and Industrial Research (*Pres. Add. Ind. Sc. Cong. 1938.*)

"It is to be anticipated that the staff required for the scientific services in India and for industrial research will more and more be drawn from students trained in the Indian Universities. It is thus imperative that the Universities should be in a position not only to give a sound theoretical and practical instruction in the various branches of science, but what is more difficult, to select from the main body of scientific students those who are to be trained in the methods of research. It is from this relatively small group that we may expect to obtain future leaders of research both for the universities and for general research organizations. This is a case where quality is more important than quantity, for experience has shown that the progress of science depends in no small degree on the emergence of men of outstanding originality of mind who are endowed with a natural capacity for scientific investigations and for stimulating and directing the work of others along fruitful lines. Leaders of this

type are rare but are essential for the success of any research organization. With inefficient leadership, it is as fatally easy to waste money in research as in other branches of human activity."

What makes a Director of Research?

As this is rather an important point we further quote from the report of the Committee of the Privy Council of the Department of Scientific and Industrial Research, England (p. 22, Report for 1922-23).

"The degree of success achieved and the rapidity with which an industry comes to look upon its research associations as a factor in its well-being, must, however, largely depend upon the choice of the right type of director to organize and supervise the fulfilment of research programme. Not only must he be of sufficiently high scientific attainments, but he needs to have the power of exposition."

In India, good directors are more often an exception rather than a rule, mostly because people come to occupy these positions from the rank of Government servants according to their seniority but irrespective of their actual qualifications. We can take as an instance the recently started Industrial Research Bureau in which the workers, who are unfortunately classified in junior grades are, we are given to understand, efficient and up to the mark but the choice of the Director and the high paid officers expected to guide the research work of the lower staff (who are as much qualified as their officers) leaves much to be desired. Same is the case with the Imperial Institute of Sugar Research, Cawnpore, where the Sugar Technologist to the Imperial Council of Agricultural Research has been appointed the Director—a man who has never handled any research problem. The results of these institutions are too obvious to be dilated.

How to get such Workers?

The selection of such potential investigators and leaders is by no means an easy task; for success in examination in science is no certain criterion that the student is fitted for research career. A preliminary training in research methods is required to select those who possess the requisite qualifications for originality and aptitude for investigation. A system of grants-in-aid or scholarships to approved students may be required for such post-graduate training. In Great Britain the financial help given by the universities and other educational institutions for training in research is in many cases supplemented by maintenance grants to promising students awarded by the Department of Scientific and Industrial Research. This system has proved of much value both in developing the research of the universities and in providing a supply of competent men both for research in pure science and in industry.

Conditions under which Research Work can be done

Something must be said about the conditions under which research work can be done. The Industrial Commission recognized the importance of this point. It observed: (pp. 77—78)

"We have found scientific experts forming heterogeneous groups, with no uniform conditions of service, with no definitely established policy or precise limits to their activities. The results are waste of money in duplicating the equipment, absence of combined efforts to form satisfactory reference libraries, overlapping of research work on some questions with consequent neglect of others, absence of authoritative check as to the value of the results, confusion among the general public and disconcerting variety of isolated or short-lived serial publications................They are in isolated posts, generally with no official prospects of promotion of a kind that would satisfy any scientific man of energy and ability......Many of the scientific specialists quickly reach their maximum salary and witnessing the gradual rise in pay and position of their contemporaries in other services, naturally grow discontented, and consequently become of reduced value to the country. In view of the fact that no quantitative standard can be established to gauge scientific research, no one can say what the country loses by discontent among its scientific staff."

In a similar strain the Committee of the Privy Council writes:

"Staff, however devoted, cannot be expected to give a single-minded attention to their work if they are anxious as to their future for reasons in no way connected with their efficiency."

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Emoluments of Workers

Appreciating these points the Industrial Commission recommended a scale of pay for the industrial researchers as Rs. 450-50-1500. This scale might be a little too liberal as pointed out by Pandit Malviya in his note of dissent, but, for example, the present scale of Rs. 150-10-300 given to the researchers of the Industrial Research Bureau is disgracefully low. The funny thing is that the above scale was accepted by the Government of India when attempting to organize the scientific services probably in the hope that most of the services will be manned by Europeans, when, however, they came to translate the scheme, as they did by creating the Industrial Research Bureau they adopted the above mentioned scale for the Indian workers. It may be recorded most emphatically here that no good work will be done by such a band of underpaid and dissatisfied workers, howsoever capable they may be. The proper procedure ought to have been to have cadres similar to those present at the National Physical Laboratory, England, where there are several grades of workers between the lowest and the highest (their salaries are in the ratio of 1: 5, unlike that of the Industrial Research Bureau here, where the ratio is about 1: 15) and the former can aspire and work for getting the latter.

Organization of Industrial Research Work in England

Coming now to the proper organization, it is to be borne in mind that the organization of research for industry and for general national purposes will, in essence be the same for all countries, though it may vary in detail. We notice that this organization not only in Great Britain but in its dominions as well, is national in scope. Early in war the British Government recognized just as the Indian Government did, that when peace would come, a more systematic application of science and research over a broader field was essential in the national interest, and, amid the distractions of war, set up the necessary machinery to accomplish this. In 1915 the Department of Scientific and Industrial Research was formed. Its formation marked the first comprehensive and organized measure taken in Great Britain to help industry through the application of science. A number of new research organizations were set up, controlled and financed by the Department to deal with the scientific aspects of the subjects of great importance to the common welfare of people but on which little, if any, organized research had been undertaken. This department took over the control and guidance of the other scientific departments of the government, *e.g.*, the Geological Survey and the National Physical Laboratory. It further made arrangements to promote the application of scientific knowledge to the problems of individual industries... Small factories, which form the majority in every country, are not in a position to maintain research laboratories on anything but a small and inefficient scale. To overcome this difficulty, the Department, in conjunction with industry instituted a number of co-operative research associations representing the greater part of the main industries of the country. Each of these research associations is autonomous and controlled by the representatives of the industry concerned and is financed by contributions from firms belonging to the association, assisted by grants from the Department.

How the Research Organization actually Runs?

This healthy and sound experiment in the co-operative organization of research has proved a great success. In this connection the late Lord Rutherford remarks thus:

"I can speak with some knowledge of the marked progress made by these two types of research organizations, as I have been privileged as Chairman of the advisory Council of the Department of Scientific and Industrial Research for the past eight years, to come in a close contact with them. While much still remains to be accomplished there has been a great advance in recent years in the recognition of the value of research in increasing the efficiency of industry. If we are to hold our own in face of the ever increasing competition in the world to-day, it is essential that our industries should take full advantage of the resources which science places at their disposal."......

"In Great Britain, the responsibility for planning the programmes of research, even when the cost is borne directly by the government, rests with research councils and committees, who are not themselves state servants but distinguished representatives of pure Science and Industry."

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Working Details of the Research Organizations

We must, if we are to achieve anything, first adopt the constitution of the governing and advisory bodies of all these scientific activities of the State on the model of the Department of Scientific and Industrial Research in England or of *Direction des Recherches Scientifiques et Industrielles et des Invention* in France. In England there is an advisory council composed only of eminent scientists and industrialists which determines the scope of research work and distributes funds, to various activities, placed at its disposal by the government. Every single scientific activity has its own committee and sub-committees composed only of specialist scientists to direct work on it. The research laboratories are guided by directors who are eminent scientists and are manned by competent workers. Their salaries and future prospects are such that they are satisfied with the work in their hand. In addition to these there are various co-ordination committees composed, as ever, of only eminent scientists. Their function is to bring about the co-ordination of the various departments of the government and the research laboratories in the solution of problems which necessitate such an action. As an example we may mention co-ordination committees on physics, chemistry and engineering.

How to Achieve this in India?

In India it is necessary that all the various scientific activities going on in the country receiving financial assistance from the government be placed under the guidance of councils composed of eminent Indian Scientists and Industrialists. The following will give an idea of the various activities meant here:

(1) Geological Survey.
(2) Forest Research Institute.
(3) Research Laboratory Soft Coke Cess.
(4) Research Laboratory Indian Central Cotton Committee.
(5) Research Laboratory Indian Jute Committee.
(6) Industrial Research Bureau.
(7) Imperial Council of Agricultural Research.
(8) Indian Institute of Science.
(9) Research Laboratory of the Army Department.
(10) Lac Research Institute.

There might be several others of similar type.

In addition to carrying on national surveys of raw materials and carrying on industrial research, the advisory council should hold periodical conferences with the businessmen, capitalists, industrialists and economists on new industries to be started in India and if the conference comes to some decision about the starting of any new industry, steps should be taken to send a sufficient number of brilliant young Indians to foreign countries to learn the various technical processes of that particular industry and to arrange to start the industry only on their return from abroad.

In this connection it is worth while to quote the late Lord Rutherford (Presidential Address, *Ind. Sc. Cong. 1938*).

"It is to be hoped that if any comparable organization is developed in India, *there will be a proper representation of scientific men from the universities and corresponding institutions and also of the industries directly concerned.* It is of the highest importance that the detailed planning of research should be left entirely in the hands of those who have the requisite specialized knowledge of the problems which require attack. In the British organizations there is no political atmosphere, but, of course, the responsibility for allocating the necessary funds ultimately rests with the Government."

Advantage of such a Constitution

To quote the words of the Committee of the Privy Council about the advantage derived from this kind of constitution (pp. 16, 18, report for 1921—22):

"One purpose of the co-ordinating functions assigned to the department is to secure economy in expenditure and in the use of scientific workers available for research. This economy cannot be effected if the financial arrangements adopted are not such as to permit other departments of state to approach the research department when an unforeseen requirement arises; otherwise there would be a tendency for departments to conduct their own research work by means of organisations not necessarily the most appropriate for the purpose."

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"It is not merely by the conduct of research that the department is adding to the national wealth or saving the pocket of the tax-payer. Though its expert boards and committees, it is often able to prevent expenditure which scientific considerations show to be unnecessary......The existence of a body devoted to the conduct of scientific research in a field so broad as that committed to us must inevitably, if it is efficient, collect in course of time a mass of detailed information and experience, both of men and of procedures, which is of the greatest possible value, not only to other departments in the preparation of their plans, but to all other bodies interested in the prosecution of research in the development of industry."

Conclusion

In the end we can hope for a speedy fulfilment of the above, as did the authors of the report on Indian constitutional reforms 1918, because,

"On all grounds, a forward policy in industrial development is urgently called for, not merely to give India economic stability; but in order to satisfy the aspirations of her people who desire to see her stand before the world as a well-poised, up-to-date country; in order to provide an outlet for energies of her youngmen who are otherwise drawn exclusively to government service or a few overstocked professions; in order that money now lying unproductive may be applied to the benefit of the whole community; and in order that the too speculative and literary tendencies of Indian thought may be bent to more practical ends and the people may be better qualified to shoulder the new responsibilities which the new constitution will lay upon them.

These are political considerations peculiar to India itself. But both on economic and military grounds imperial interests also demand that the natural resources of India should henceforth be better utilized. We cannot measure the access of strength which an industrialised India will bring to the power of the Empire; but we are sure that it will be welcome after the war."

Industrial Inefficiency of India

Lest anybody be under the illusion which is very often produced by official propaganda, that India has made any substantial progress towards industrialisation let us quote from a very interesting book *Economic Development of India* (1936) by Dr Vera Anstey

'Here is a country of ancient civilization, with rich and varied resources, that has been in intimate contact with the most materially advanced countries of the West, but which is still essentially mediæval in outlook, and organization, and which is a byword throughout the world for the poverty of its people.'

Then she quotes Mr M. L. Darling:

'The most interesting thing about India is that her soil is rich and her people are poor' and asks herself:

'Can India be called "Mediæval" when it is organized under a modern form of constitutional Government, possesses a great system of mechanical transportation, a unique system of irrigation, no less than seventeen modern universities, and has several large-scale industries producing with the most up-to-date machines that have yet been invented?'

As a quantitative measure of the poverty the following figures will suffice:

Consumption	England	Japan	India
(Electricity per head in kWH units), 1936 ..	450	340	8
Coals (in tons) ..	4.93	.7	.06
Iron (in tons) ..	.28	..	.007

Studies in Indian Snake Venoms

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Scientific Classification of Snakes

POISONOUS snakes are divided into two great families, the *Colubridae* and the *Viperidae*.

The *Colubridae* type resembles the harmless snakes and are therefore all the more dangerous. They are divided into two groups, *Opisthoglypha* and *Proteroglypha*.

The *Opisthoglypha* group includes three subfamilies:

A. *Homalopsinae*.

B. *Dipsadomorphinae*.

C. *Elachistodontinae*.

All the *homalopsinae* are aquatic. They are met commonly in the Indian Ocean, starting from Bombay and especially in the Bay of Bengal.

The *Proteroglypha* group of the *Colubridae* family is of much greater importance, since all the snakes belonging to it are armed with powerful fangs. This group is composed of two subfamilies:

A. *Hydrophiinae* (Sea-Snakes).

B. *Elapinae* (Land Snakes).

The *Viperidae* family is divided into two subfamilies:

A. The *Viperinae*.

B. The *Crotalinae*.

The *Elapinae* sub-family belongs to the genera

(*a*) *Bungarus*.

(*b*) *Naja*.

The Asiatic *Viperinae* belong to the genera

(*a*) *Vipera*.

(*b*) *Pseudo Cerastes*.

(*c*) *Cerastes*.

(*d*) *Echis*.

Indigenous Classification

It will be interesting here to mention that there has arisen an indigenous system of classification of snakes due to the constant and minute observation of the snake-catchers who are also healers of snake-bite. They are known as mal badyias in Bengal. They divide the snakes into two groups:

(1) Poisonous.

(2) Non-poisonous.

The poisonous snakes are usually of four varieties:

(1) *Baraphani*,

(2) *Gokshura*,

(3) *Keuta*, and

(4) *Bora*,

and are known as *chou-sáp* (*chou* - four *sáp* - snake). The group *Baraphani* is composed of the following members:

(*a*) *Patraj*,

(*b*) *Dudhraj*,

(*c*) *Bankaraj*,

(*d*) *Shankarchur*, and

(*e*) *Manichur*.

The *Khoya Gokshura*, *Kali Gokshura* and *Padma Gokshura*, consititute the Gokshura group. Various kinds of *keuta* constitute the group of that name *Shamuk-bhanga Keuta* is notorious.

In the *Bora* group, *Chandra bora* is very dangerous. Though the snake called Kanada or Krait otherwise known as poisonous chitta is poisonous and especially dangerous. It is not included in the list by mal-badyias, probably because of its socially lesser position among the members of the serpent family. The Kraits may be found anywhere in Bengal, in the house, in your bed, in earthen pots,

in the fissures and cracks of walls and the folds of quilts. They fall from the ceiling when it is a thatched house.

However, the following are the poisonous snakes found in Bengal:

(1) The Cobra (*Naja Naja, Naja Tripudians*).

(2) Keuta.

(3) The Shankarchur or the Hamadryad (King Cobra).

(4) The Krait or Kanada (Bungarus Fasciatus).

(5) Chandra bora (Russell's Viper).

(6) Shakni (*Bungarus Caerulus*).

(7) Hafae (*Echis Carianatus*).

Collection of the Venom

Poisonous snakes possess special glands capable of secreting venom. The poison glands occupy an extensive intramuscular space behind the eyes, on each side of the upper jaw. They are oval in shape and may attain the size of a large almond as in the case of the *Naja Tripudians*.

At the moment the snake starts to bite, it opens its jaw directing its fangs forwards; then the muscles that come into action compress the glands on each side and cause the venom to be expelled in a sudden jet. In the case of certain species, the venom may be projected to a distance of more than a yard. Venom can be extracted from the poison glands of both the freshly killed and living snakes.

The Indigenous Method of Extraction

The head of the reptile is held by the left hand and an oyster-shell (used as a spoon in India) is forced into its mouth. The shell is covered with a palm leaf. The mouth of the poison sac is opened and the poison comes in continuous stream through the fangs. After a second or two, the stream is reduced to drops and at last the drops cease altogether; and this shows that the sacs have been exhausted.

It takes several seconds to empty the sacs. The spoon or the shell is then removed and found to contain about 1-4 drams of poison. If a drop of the poison is taken and rubbed on the skin, one will mistake it for soap. If the palm-leaf, which has been pierced through by the fangs is now examined two punctures will be found about a quarter to half an inch apart.

In modern practice for the collection of the venom, all that is required to be done is to take special precautions so that the animal cannot coil itself round any object near the operator. It is wise to begin by pinning down the head of the serpent by means of a stick and to seize it with a pair of long fenestrated tongs shaped like forceps. Sometimes, the serpents are chloroformed so that they can be easily handled.

Freshly collected venom is a syrupy liquid tinged slightly yellow. It is said that its taste is very bitter. It is entirely soluble in water. The density varies from 1.03 to 1.05. Tested with litmus, the solution is slightly acid (pH 6.2). All kinds of venoms are not equally affected by heat. The venom of the *Colubridae* family can easily stand a temperature up to 86°C, whereas those of the *Viperidae* family lose their toxicity at 70°C.

When the venom has been collected, it must be quickly dried in a desiccator over $CaCl_2$ or H_2SO_4. The dried venom looks crystalline, but actually it is not so; the appearance is like that of dried gum-arabic or albumen. In this dry condition, placed in well-corked bottles, protected from damp air, it may be kept almost indefinitely without losing any of its original toxicity.

Minimum Lethal Doses (M.L.D)

It is very difficult to specify, within broad limits, the dose of venom which will prove fatal for an adult. The quantity of venom introduced by the bite of a venomous snake depends upon a number of factors and very fortunately, the quantity of venom poured, is not always sufficient to cause death. Thus, in Bengal, specially on the banks of the Padma in the rainy season, when snakes are most numerous and most dangerous, the mean mortality scarcely exceeds 35-40% of the individuals bitten.

By experimenting upon animals and commencing with known doses of venom, which has first been dried and then dissolved in physiological saline or

sterile distilled water, the minimum lethal dose has been determined.

The average M.L.D. for a pigeon of average weight 300 gms. is given below:

0.1 to 0.3 mg.—Cobra Venom (intramuscular).
0.01 to 0.02 mg.—Russell's Viper (intravenous).
1.8 mg. —Krait (intramuscular).
0.025—0.05mg.—Echis Carianatus (intravenous).
In general, the M.L.D. is directly proportional to the weight of the animal.

M.L.D. of cobra venom for dog 0.8 mg. p. kg.
" " horse 0.05 mg. p. kg.
Assuming that man, in proportion to his weight, possesses a resistance intermediate between that of the dog and that of the horse, we may consider that the lethal dose for man of average weight 60 kg. is 6 mg. *i.e.*, the M.L.D. for man per kg. is 0.1 mg. It follows that 1 gm. of venom would kill 10,000 kilos of man or let us say 165 persons of average weight 60 kg.

Physiological Action

The physiological action in the case of severe cobra-bite is quite different from that in the case of Viper bite. Cobra venom contains two toxic substances Neurotoxin and haemolysin. The former is mainly responsible for the death of the victim. It paralyses the nervous tissues while haemolysin causes partial haemolysis of the r.b.c. The Cobra venom produces no local effect over the site of the bite. The bite is not very painful in this case. It is characterised by the numbness that supervenes in the bitten part, rapidly extending throughout the body and producing dizziness and fainting. The patient soon experiences a kind of lassitude and an irresistible desire for sleep; his legs get weaker and weaker and can hardly support him; the breath becomes difficult.

By degrees, the drowsiness and the difficulty of breathing become greater. The pulse which at first is more rapid, becomes slower and gradually weaker. The mouth contracts and there is profuse salivation. The tongue appears swollen, the eyelids remain drooping and after a few hiccoughs frequently accompanied by involuntary emissions of urine and faecal matter, the unfortunate victim falls into the most profound coma and finally dies. The pupils of the eyes react to luminous impressions up to the last moment and the heart continues to beat for some time (even two hours) after respiration has ceased. All this takes place from 2—6 hrs.

Haemorrhagin present in Russell's Viper venom produces extensive haemorrhage. The seat of the bite immediately becomes very painful and first red, then purple. The surrounding tissues are soon infiltrated with sanguinolent serosity. Sharp pains accompanied by attacks of cramp extend towards the base of the limb. The patient complains of intense thirst and extreme dryness of the throat and the mouth. These phenomena continue for a very long period, even for 24 hours.

Chemical Study of Snake Venoms

The elementary chemical analysis of Cobra venom gives the following results:

C—43.04%	H—7.00%
N—12.45%	S—2.50%

The venom extracted from the poison glands of snakes contain a number of substances of more or less uncertain chemical composition. They can, however, be broadly classified into proteins and non-proteins. The protein content of cobra venom is about 94% and constitutes the largest fraction of the dried venom; the toxins and the enzymes are always found associated with it.

Cobra venom contains (1) Neurotoxin, (2) Haemolysin and also (3) Enzymes.

It has been possible to separate the neurotoxin from the haemolysin and to purify them to such an extent that for the same nitrogen-content, the purified samples of neurotoxin and haemolysin are about 17 and 4 times more active respectively than the dried crude venom (Ghosh and De).

It has also been shown that Cobra venom and Russell's viper venom contain proteolytic enzymes, the optimum activity of which is in the region of pH 7—0 with casein as substrate and at pH 8—8.2 when gelatin and egg-albumen are used. Further, it has been shown that these venoms can oxidize haemoglobin to methaemoglobin and can hydrolyse Witt's Peptone, the pH for the latter reaction being 8.2—8.4 (Ghosh and De).

Ganguly and Malkana have shown that lecithin and cholesterol are present in cobra venom. The protein fractions contain

Globulin ..	20.31%
Albumen ..	39.69%
Primary Proteose	11.31%
Secondary Proteose	16.81%

The toxicity is associated with the secondary proteoses.

The chemical analysis of Russell's viper venom shows that it contains C, H, N, S, O. No phosphorus is present and accordingly no such substance as lecithin is present. The protein-content of the dried venom is about 96% and the protein fractions contain

Globulin	23.35%
Albumen	22.12%
Secondary Proteoses ..	50.52%

The neurotoxic, the coagulant and the haemorrhagic action of Russell's viper venom are attributed to the secondary proteoses (Ganguly and Malkana).

Therapeutic Uses of Snake Venom

Rusell's viper venom solution is extensively used for haemostatic purposes. Investigations are being carried out on the possibility of the use of cobra venom in cancer-treatment, but no definite conclusion has yet been arrived at as to its efficacy. Cobra venom in small doses is used to relieve neuralgic pain.

Treatment of Sanke-bite

In practice, the rational treatment of the bite of a venomous snake must be directed towards

(1) Preventing absorption of the venom.

(2) Neutralising, by injection of a sufficient quantity of Antivenomous serum the effects of the venom already absorbed.

In order to prevent the absorption of the venom introduced into the wound, the first precaution to be taken is to compress the bitten limb by means of a ligature of some kind. The ligature must be tightly twisted and by compressing the tissues around the bite, an attempt should be made to squeeze out the venom that may have been introduced into them. The ligature should not be applied for more than half an hour, otherwise, it would interfere with the circulation of blood to a dangerous degree and would certainly injure the vitality of the tissues. The wound should then be washed freely with a fresh 2% solution of hypochlorite of lime or with a 1 in 100 gold chloride solution. A KMnO solution (1%) may also be employed.

The next thing to be done is to apply the serum therapeutic treatment. This treatment is specific. Unless we know the kind of snake which has bitten, this treatment cannot be applied with any reasonable chance of success. Nowadays, polyvalent serum is available which can be applied generally. The serum should be injected intravenously. The volume of the serum necessary is atleast 40 c.c. for complete cure when the bite is not severe*

*Read at an ordinary meeting of the Calcutta University Chemical Club on 26-7-38.

Symposium on Weather Prediction

UNDER the auspices of the National Institute of Sciences of India, a Symposium on Weather Prediction was held in the Meteorological Office, Poona, on the 25th and 26th July, 1938. Various aspects of forecasting of weather were discussed at the symposium, attention being focussed mostly on the problems facing the Indian meteorologist and the proposed or attempted methods of solution. Thus, papers presented at the meeting concerned long-range forecasting for a whole season as developed in India, medium range forecasts for *10-day periods as developed by the German and Russian schools, short-range, i.e., day-to-day, forecasting in India*; with special reference to the use of air-mass analysis in this task, the problem of forecasting Nor' westers, the use of upper-air data in weather forecasting, thermodynamic studies of the atmosphere with special reference to latent instability, rainfall in Northwest India associated with winter disturbances, weather forecasting for aviation and the application of kinematical methods to forecasting.

In his opening remarks, Prof. M. N. Saha, President of the Institute, said that " Symposium " meant drinking together and at Poona, the Headquarters of the Meteorological Survey of India, they had assembled to drink from the cup of knowledge offered by the department. He referred to the importance attached to the art of weather prediction, or rather weather-making in early times, and said that amongst certain tribes, the man who could bring about rain successfully by his magic was promoted to kingship, and when he failed, as inevitably he must have done, he was sacrificed to appease the wrath of gods. In India, about 500 B.C., there were Brahmins who professed to be specialists in the art of rainmaking. In modern times, every civilized country has organized meteorological services to obtain the knowledge of secrets of weather by combined effort, and to forecast weather for the use of the public. The Indian Meteorological Department has been trying to forecast weather by the use of synoptic charts from the time of Blanford and Eliot, and after the War, Indian Meteorologists have made substantial contributions to Weather Physics. But up to this time, the problems have proved to be far too elusive, and the day seems to be far distant when meteorological conditions may be predicted with the same precision as the position of plants or other astronomical events. He hoped that the discussions presented to the symposium would lead to a better understanding of the problems.

Dr C. W. B. Normand welcomed the visitors to the symposium on behalf of the Meteorological Department and reviewed briefly the complexities of the problems which faced the meteorologist. At one time, it was sufficient for the forecaster to restrict his attention to rainfall alone. Now the conditions had altered largely; the meteorologist had not only to forecast for storms over the sea and land but had to warn the airman who wanted detailed forecasts of upper winds, of height of clouds, of fog, dust-storms, squalls, etc. A variety of requirements had thus to be satisfied and yet his decisions had to be made quickly. There was no time for lengthy calculation such as would be necessary if he desired to, and could write complex mathematical equations relating to the weather situation at any instant and solve them to obtain the picture at a future instant. The most hopeful method from the practical point of view appeared to be to focus attention on the identification of air masses, homogeneous within themselves, and to the effects which a mutual interaction between the several air masses would produce. India was the country in which most attention had been paid to the subject of seasonal forecasting and yet, the most that we could do to-day was to give a very general indication of total rainfall over large tracts of the country for a period of two to four months. Dr Normand concluded by giving a brief general survey of the different aspects of the problem which was to be dealt with in detail by the subsequent speakers.

SYMPOSIUM ON WEATHER PREDICTION

Story of Long Range Prediction in India

Dr S. R. Savur told the story of seasonal (or long period) forecasting in India. The first forecast of monsoon rain, mainly based on the data of snowfall on the Himalayas and the Sulaiman range during the preceding January to May, was issued by Blanford in 1886. Eliot who succeeded Blanford added other factors like the southeast trades at Mauritius, Zanzibar and Seychelles, data of south Australia and Cape Colony and "Nile Flood". But in his method which was mainly graphical there was much chance of individual bias. A great improvement in foreshadowing monsoon rainfall resulted when Sir Gilbert Walker introduced the more impersonal method of correlation coefficients in place of Eliot's graphical method. The first forecast using a regression equation was issued by him in 1909. In 1924 he worked out six formulae for forecasting rain in the Peninsula, Northeast India and Northwest India in which use was made of some 28 factors selected out of a large number after applying the statistical test, now named after him. Mr Field, the pioneer of upper air work in India, was responsible for suggesting a new factor of special interest, *viz.*, use of upper air data in seasonal forecasting; his factor is the upper winds of Agra, in autumn to foreshadow the winter rains in Northwest India. The re-examination of the data in recent years and the application of the Performance Test showed a dimunition in the significance of some of the factors. Nevertheless, the total correlation coefficient is still found to be 0·63 for total monsoon rainfall of the Peninsula and 0·64 for that of Northwest India and 0.72 for the winter rains of Northwest India. The present forecasts issued at present are for (*i*) the winter rainfall during January to March in Northwest India. (*ii*) the monsoon rainfall during June to September in Northwest India and the Peninsula and (*iii*) the monsoon rainfall during August and September in the same two divisions. Efforts were being made to decrease the period of the forecasts and also the area which they covered. Dr Savur emphasized that methods of correlation were strictly applicable only when all the quantities correlated varied according to the normal law of distribution. To overcome the handicap introduced by non-normality of distribution found in practice, general methods were being developed but the work was still in its initial stages.

German Forecasts for 10-day Periods

Mr S. Basu gave an account of the technical preparation of the 10 day forecasts issued by the German Meteorological Service which, he said, rests on a combination of statistics and synoptics.

The first consists in the determination of the connection between the 'foreweather' and the 'postweather' in the chosen interval of time by computing correlations, the choice of the elements and the interpretation of results depending on the physical-meteorological view points. This statistical handling of 'weather history' makes up the principal part of the work.

The second part of the work consists in the *individual study and analysis of the 'broad weather situation' of the 'forecast day'. With the help of 'multiple correlation tables' definite days are* extracted from the history of the weather in which the development of the weather was similar to that of the forecast day. Any rhythms appearing in the march of meteorological elements up to the forecast day are also followed up and the possibility of an extrapolation is weighed.

For the synoptic analysis of the situation, pressures and temperatures of the free air up to 5 km. of the forecast day and the preceding day, based on observations of the weather aeroplanes, are examined. For the 24-hour changes at the ground level the control by the pressure at 5 km. has been found to be very complete and has been called 'steering' by the Frankfurt School. Four types of steering, *viz.* Northerly, Easterly-, Trough- and Double-Steering, are recognized by Baur. Since the pressure gradient in the lower stratosphere, the average gradient of temperature in the troposphere and the general flow have a marked correspondence with the steering, which persists for some days, Baur considers this as the basis of the 'broad weather situation' determining the outlook.

Forecasts for Periods by the Russian School

In the 'composite map method' of forecasts developed by Multanovsky and his collaborators the time-interval for the forecast is determined by the

period which marks the type of the synoptic process involved.

The method is founded upon the basic idea that the weather is 'made' in the north sub-polar regions instead of moving from west to east with the general circulation. Owing to lack of adequate data from sub-polar regions, an indirect approach was made to work out this hypothesis by analyzing trajectories of pressure maxima grouped according to their origin. Three groups of trajectories were obtained; *viz.*, the normal polar type, the ultra-polar type and the Azores normal type. The positions of the axes of these groups, some of which are characterized by great stability, over certain regions call for completely determined types of weather in corresponding regions.

'Composite maps' are prepared by entering the centres of areas of high and low pressures, crests of high pressure and secondary minima accompanying the movement of the maximum. With the aid of the axes one can determine the distribution of pressure fields on the composite map and, conversely, a change in the orientation of the process can be determined from the distribution of the pressure fields. A weather type can best be identified by a combined composite map which is illustrated with the corresponding distribution of temperature, precipitation and wind associated with a given process. The trajectory of the anticyclone allows a determination as a first approximation of the origin and extent of modification of the air-mass; the further details of the weather are obtained from the pressure distribution.

The 'natural synoptic period' characterizing the weather type during which the pressure centres continue to form definitely marked pressure fields and an 'operation' continues along any definite axis is generally of 10 to 12 days' duration. Hence two or three days after the beginning of the new period, as soon as the orientation of the process becomes apparent, it is possible to determine the weather for the next 7 to 10 days.

It was observed that during the course of a whole series of changes leading to any typical phenomenon, there usually occurs 30 to 35 days previously a sort of 'flaring up' of a new process, or 'a threat'. Within this time interval one can distinguish approximately 5 or more 'moments', the pressure distribution in which represent the 'phases' leading to a 'development' along an axis having a definite direction. On the average there are 4 to 5 phases to the period of 30 to 35 days, though a phase may range from 6 to 15 days. The introduction of phases, and threatening moments associated with them, has made it possible to enlarge the forecasts considerably and to widen their scope. The most pronounced indication appears on the 13th to 14th day after the appearance of a threatening nucleus; this day on which is also indicated the region where an event is to occur is called the 'Regional day'.

An extension of similar considerations as above has enabled Multanovsky to prepare composite maps for seasonal forecasting also. For this purpose the western half of Siberia, Europe and the neighbouring seas are divided into 40—80 districts; with data from these districts atlases of composite maps and maps of typical operational areas of pressure maxima have been prepared for comparison with maps for any individual season for which forecasts have to be issued.

Mr S. Basu thought that the German method may be given a trial in India. He thought that the Russian method did not apply to Indian conditions.

Regarding the way in which these predictions are worked out, he read the following opinion of Sir G. W. Walker.

"The actual preparation of a monsoon forecast in India is simplicity itself by comparison with this (Franz Baur's) method.'

Judging from the performance of the method for a number of years, it appears to have achieved a high measure of success in Germany.

Dr S. N. Sen explained the methods adopted in daily forecasting practice for identification of air masses which, broadly speaking, fell into two classes, oceanic and continental but could be subdivided into several sub-classes. He illustrated by means of charts certain types of stationary fronts which often developed over the Indian area. He also showed how use was made of stream lines and convergence patterns of air currents aloft deduced

from pilot balloon data and cloud movements, along with a knowledge of upper air climatology for identification of air masses and day-to-day forecasting.

Dr S. K. Pramanik spoke on the application of air mass analysis to the problem of forecasting of Nor'westers in Bengal. He reviewed the work of the various meteorologists in India who have written about the mechanism of Nor'westers. He said that while some of the Nor'westers might be due to the action of cold fronts or undercutting by cold easterly Himalayan air, the majority of those which occurred in the afternoon depended upon some insolation effect. In the morning there was an inversion between ·5 and 1·5 Km. with moist air below and dry air above generally with latent instability. The effect of insolation was like heating unequally a slightly inclined liquid from below with the result that convection currents rose irregularly over the country. With the advance of day and greater heating these convection currents would go higher and higher and if the heating was sufficient they reached the boundary layer wiping off the inversion and causing great instability. Convection currents when they reached this layer would shoot up with great violence and the upper air would come down with a rush causing a Nor'wester. As a consequence of this the speaker thought that the occurrence or not as well as the intensity of Nor'westers would depend upon the height of inversion layer or depth of moist air and the amount of insolation and that it might be possible to forecast the occurrence of Nor'westers if the height of the inversion layer were known and one could estimate the maximum temperature in the afternoon. He also explained the lag, often noticed, between the time of occurrence of Nor'westers and that of maximum insolation. He then described the morning conditions which appeared to be necessary for the occurrence of Nor'westers in the afternoon, and he said that if these conditions occurred, Nor'westers were to be expected in Bengal.

Dr K. R. Ramanathan gave a brief review of the development of upper air work in India and explained how the data helped the issue of forecasts relating to conditions on the ground as well as in the upper air. The data provided the basic information regarding the climatology of the upper air and helped intensive studies of the structure of atmospheric disturbances. He gave a few instances of the use of these data in such studies. For instance, he showed how warm fronts somewhat similar to those in European latitudes were found to be associated with storms and depressions in the Bay of Bengal. The two air masses between which the front formed were the dry cold air from northern India and the moist equatorial air from the south Bay. A modified type of front was associated with the storms of the premonsoon season. In monsoon depressions the main front formed between fresh monsoon air and old monsoon air, the former behaving as a cold mass and the latter as a warm mass. Dr Ramanathan also showed a picture of the general circulation of the atmosphere over India as obtained from pilot baloon ascents made for the past few years in this country.

The role of *latent instability in the atmosphere* formed the subject of an interesting communication by Dr N. K. Sur; in the absence of the author the paper was presented by Dr R. Ananthakrishnan. The term 'latent instability' which was defined by Normand in 1931 referred to a thermodynamic state of the atmosphere in which, under suitable circumstances, the initial expenditure of a small amount of energy led to the release of a much larger amount of energy. Absence of latent instability was ordinarily associated with dry fine weather with occasionally high clouds of the non-convectional type, while its existence was associated with convective clouds or instability phenomena like dust or thunderstorms. Interesting series of soundings taken during the formation of storms in the Bay of Bengal and their movement showed the progressive building up of latent instability conditions as a disturbance approached the station and its disappearance as it moved away or dissipated.

Mr S. P. Venkiteshwaran read an interesting paper on rainfall due to winter disturbances and the associated upper air temperatures over Agra.

Dr S. K. Pramanik gave an account of the kind of upper air data available in India. Of these only upper wind data including directions of cloud movements, apart from aeroplane temperature data from a few stations in Northwest India, are received in time for and are actually used for day-to-day forecasting in India. He explained the limitations as regards the availability of and the kind of

information available from upper wind data. He was of opinion that the upper wind data had been of great help in day-to-day forecasting in India. He showed some sets of charts illustrating the help of upper wind in daily forecasting. They indicated occurrence of heavy rainfall with convergence of upper winds, decrease of rainfall with divergence of upper winds and stoppage of the supply of moist air currents, heavy rainfall in hills when moist air currents struck them and non-occurrence of Nor'-westers when surface conditions were favourable but upper wind conditions were not so.

Mr P. R. Krishna Rao discussed the problems which demanded attention in weather forecasting for aviators which could be divided into three categories (i) regional, (ii) route, and (iii) local. In regard to local forecasting he explained the use being made at Karachi of tephigrams of aeroplane ascents in forecasting local convectional phenomena and formation, persistence or clearing of clouds. The soundings by aeroplanes had afforded a valuable aid in this task. He also referred to the question of fog forecasting and remarked how the Taylor Diagram had not proved very successful except in ruling out days when fog was unlikely.

The use of kinematical methods in weather forecasting as developed by Dedebant and Pettersen was explained by Dr S. K. Banerji. Whenever any pressure system, such as a cyclone, an anticyclone, a trough or a front was in continuous motion one could, from a knowledge of the changes in the 2 to 3 hour period preceding, calculate the velocity and acceleration of each point of the system and foretell the position and configuration of the system during the next 6 to 12 hours. The deepening or filling up of pressure over an area bounded by two closed isobars was equal to the planimetric value of the barometric tendency within the same area. Dr Banerji illustrated an application of these and other kinematical laws to certain Indian storms, particularly to explain the curvature of the tracks of the storms.

Lively discussion took place at the end of each of the papers mentioned above.

Dr Normand who wound up the discussion referred to the future of weather forecasting. He felt doubtful whether any statistical methods applied to surface data alone would result in much further advance in seasonal forecasting. Here as well as in other branches of forecasting we had to look to the upper air for further improvements in our forecasting capacity. There lay our hope. More data of soundings of the atmosphere by aeroplanes, radio-sounds or balloon meteorographs were needed for day-to-day analysis of the conditions in the upper air which alone would help us to understand the mechanism that was behind the making of weather. As regards the German method of forecasting for 10 days, he admitted that the method was worth giving a trial, but he must ask Mr Basu to give him an estimate before the work could be undertaken.

The President, in concluding, remarked that after listening to the debates, it appeared that the problem of weather prediction, except for the short range one, appeared to be more elusive than he had thought earlier. The success of Franz Baur's method appeared to be striking, but no physical arguments have yet been given as to why the weather at the height of 5 Kms. should control that on the surface for the next 10 days. He thought that the department may give a trial to the method over a meteorologically homogeneous area, say the Panjab, for a limited period of time. He agreed with Dr Normand that a large scale survey of the upper atmosphere by means of radio-meteorographs and aeroplanes should be undertaken, and expressed the hope that in view of the importance of weather prediction to all classes of people, the Government of India should be liberal in financing such schemes. The successful advance in this direction appeared to lie in a harmonious combination of survey, analysis of data, and application of principles of mathematics and physics, and he was glad to find that the composition of the department was ideal from that point of view.

General Presidential Address

British Association for the Advancement of Science, 1938.

THE address begins with the statement of the conflict that from a stand point of general and philosophical interest the results of modern science give one the impression that what the senses tell us about the external world is shown to be altogether misleading. The President, however, points out that on the whole the tendency of progress is to bring the more remote conclusions within the province of direct observation, even when at first sight they appeared to be hopelessly beyond it. He, then, refers to the conception of atoms, to the process of radioactive decomposition and to the ordinary matter not being really space-filling and says that though these and many other points of view have seemed at first sight to contradict the direct indication of our senses, they are not really so, because they are obtained and could only be obtained by sense indications rightly interpreted. The reason for this is that our senses have not primarily been developed for purposes of research, and we have in large measure to adopt them to that purpose by the use of artificial auxiliaries. The result of doing so is often to reveal a world, which to the unaided senses seems paradoxical. Thus the main subject of the address is chosen to be a survey of the ways in which such adaptations have been made, the particular sense selected for the survey being the human eye.

The mechanism of the eye consists mainly in its lens system for focussing the image, in its retina for receiving the image and in its rods and cones—the light sensitive elements that distinguish colour. The qualities derived from such a mechanism are ideal for what we believe to be nature's primary purpose—that is for finding subsistence under primitive conditions and for fighting the battle of life against natural enemies. But for purposes of research we can increase the qualities by artificial additions over a wide range for examining the very distant or the very small, for increasing very largely the range of spectrum which can be utilised, and for enhancing the power of colour discrimination.

The invention of lenses led to that of telescopes and microscopes—the solution of the problems of distant and small objects—and is therefore one of the greatest scientific discoveries. Given perfect construction there is no limit in theory to what a telescope can do in revealing distant worlds. On the other hand there is a very definite limit to what a microscope used with, say, ordinary daylight can do, for the points on the object which are about half a wavelength apart cannot be distinctly separated, and this is the theoretical limit for a microscope using ordinary light. For this the ultra-violet microscopy is evolved and we are nearing the region of the spectrum where almost everything is opaque.

The lenses made of matter are useless for waves shorter than those used in ultra-violet microscopic work. To avoid this we can make, for certain radiations, converging lenses out of empty space. According to our present views the cathode rays in one aspect consist of a stream of electrified particles; in another they consist of wave trains, the length being variable in inverse relation to the momentum of the particles. These cathode rays have the property of being bent by electric or magnetic forces and with the analogy of the bending of light rays in its property of refraction the so-called electrostatic or magnetic lens is constructed. The wavelength associated with an electron stream of moderate velocity is so small that if the electron microscope could be brought to the perfection of the optical microscope, it should be able to resolve the actual atomic structure of crystals.

Can artificial resources help to improve colour discrimination? There is the whole subject of spectroscopy that may be thought of coming under the head. A spectroscope has got its limitation in having a fine slit. But using a compromise width, M. B. Lyot working in the clear air of the Observatory of Pic du Midi has even been able to observe the solar prominences through a red filter which enables the whole circumference of the sun

to be examined at once without the limitations introduced by a slit. There is also the spectroheliоscope by Hale for the continuous watch for the bright eruptions of the red hydrogen lines.

Next comes the problem of retina. Certainly it cannot be supplemented. But artificial sensitive surfaces are substituted which are in some respects better than the one supplied by Nature. These are photographic or photoelectric surfaces sensitive to light. As is well known, the eye has maximum sensitivity to the yellow green of the spectrum. The sensitivity of the silver salts used in the manufacture of photographic retina is maximum in the blue violet and ranges on through ultra-violet to the X-ray region. The extension of the sensitiveness on the other side through green, yellow and red to infra red was not easy. However, success has been attained, largely by the efforts of Dr W. H. Mills and of Dr Mees of the Kodak Company, and we all see the fruits of it in the photographs by lamp-light which are often reproduced in the newspapers. It is now known at what point water becomes opaque. The spectra of the major planets have been extended into the infra red, which supplied the clue as to the true origin of the mysterious absorption band due to their atmospheres which had baffled spectroscopists for more than a generation.

Another substitute for retina is the photoelectric surface. This is a clean surface of alkali metal *in vacuo* which responds to visible light and passes comparatively large currents. The credit is due to two German schoolmasters, J. Elster and H. Geitel. They could scarcely have foreseen that their work, carried out in purely academic spirit, would make possible the talking films which give pleasure to untold millions. The photoelectric cell is used like the photographic plate at the focus of an astronomical telescope. It has been applied with success to guiding a large telescope or, in a humbler sphere, to open doors or even to catch thieves. Another interesting application of the photoelectric cell is in the measuring of the diameters of nebulae. Stebbins and Wintford have found, by attaching a photo cell to their telescope, that the linear dimensions of the great Andromeda nebula is twice as great as had been concluded from visual photographs.

The photoelectric cell is also instrumental in the development of television. Here the photoelectric surface is divided into minute patches which are electrically insulated from one another, and unlike the natural eye which has probably half a million connections between the human retina and the brain it has got only one single connection which is in effect attached to each of the patches in rapid succession by the process of " scanning " the image. With such a photo-cell the transmutation of a momentary image into a series of electric pulses is very easily effected, and which are amplified and sent out as wireless signals to turn back again into visible picture at the other end. Dr V. K. Zworykin has suggested that this electric eye or iconoscope, as it has been called, can be used to make visible the image in the ultra-violet microscope. It may also be used for raipd photography if the photographic plate replaced the viewing screen. The beauty of the device is that the energy is supplied locally, the distant light source merely releasing it.

In winding up the subject the Rt. Hon'ble President emphasized that main triumphs of science lay in the tangible facts which it had revealed; and it was these which will without doubt endure as a permanent memorial to the present epoch. Thus the main thesis of the address had been that these were discovered by methods not essentially different from direct scrutiny.

The second part of the address is on " Science and Warfare." Science, it is urged, is the source of all the trouble, since the important weapons of modern warfare, the high explosives, the poison gas and the thermite incendiary bombs and the aircraft are all products of the effort belonging to men trained in science. Tracing the history of the discovery of each of them it has been shown that military objects were certainly not the incentive of the successful investigators, who proceed with the spirit of scientific curiosity and with no possibility of telling whether the issue of their work would prove them to be fiends, or dreamers or angels. For good or ill, the urge to explore the unknown is deep in the nature of mankind. The world is waiting in readiness to snatch away the results of this urge, and to use them for its own purposes.*

* An abstract of Lord Rayleigh's address.

Extension of the Periodic Table and the Elements beyond Uranium

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On examining the Periodic Table we find that the number of naturally occurring elements from hydrogen to Uranium is 92. This has been confirmed by Moseley's researches on X-ray spectra and the determination of atomic number.

Of these 92 elements two remaining still undiscovered are the elements Nos. 85 (Eka-iodine—a homologue of iodine) and 87 (Eka-Caesium—a homologue of Caesium). Recently Horia Hulubei in France claims to have discovered the element No. 87 by means of curved crystal focussing spectrograph in the mineral Pollucite. To this the name Modavium has been given.

The Periodic Table is characterised by a number of well-defined periods based on the gradual filling up of successive quantum groups by electrons. Thus we have:—

1st Period of two elements with 1st quantum group completely filled up;

2nd Period of eight elements with 2nd quantum group completely filled up;

3rd Period of eight elements with 3rd quantum group partially filled up;

4th Period (long) of eighteen elements with 3rd quantum group completely and the 4th quantum group partially filled up;

5th Period (long) of eighteen elements with both 4th and 5th quantum groups partially filled up;

6th Period (long) of 32 elements with 4th quantum group completely and both 5th and 6th quantum groups partially filled up;

7th Period (incomplete) of six elements only with new electrons added to the 6th and the 7th quantum groups.

This last or the 7th period has certain characteristics of its own and does not follow the developments of earlier periods. A group resembling the rare-earths between actinium and thorium is missing here—an interruption or break in the otherwise continuous thread. Actinium may be regarded as the sole representative here of the rare-earth elements of the preceding period.

All the elements of this period, as well as polonium and radon of the previous period, are unstable and naturally radio-active. This period ends abruptly in the middle without arriving at a partial stability in an element of pseudo-inert gas structure like eka-platinum and a final stability in an element like eka-radon, as is the case with the foregoing periods. It is believed that with increasing atomic weights the atoms become more and more unstable and the existence of elements beyond uranium in nature becomes consequently an impossibility. Even if they would exist, they would have been too short-lived to be detected.

All the radio-elements, produced by the spontaneous disintegration of the heaviest elements Th and U, are found to be isotopic with one or other of the naturally occurring elements of the 6th or the 7th period.

Discovery of numerous isotopes of commoner elements by Aston and the artificial transmutation of elements by bombardment of the atomic nuclei with projectiles like α-particles, neutrons, fast protons and deuterons have added to the heterogeneity of our elements. The ultimate products of all artificial transmutation are stable nuclei identical with isotopes of commoner elements. There are very few stable elements now which have not yielded to this artificial disintegration and we are thus acquainted with numerous nuclear chemical reactions

EXTENSION OF THE PERIODIC TABLE AND THE ELEMENTS BEYOND URANIUM

dealing with changes in the atomic nuclei. It should, however, be noted that one or other of the fundamental particles, already mentioned, always forms a reacting unit in these reactions.

Besides these we are now furnished with a number of new unstable isotopes of known elements as intermediate stages in many of these artificial transmutations. These break down with emission of positrons or electrons. The phenomenon goes by the name of induced radio-activity.

Curie and Joliot prepared for the first time this type of artificial radio-active atoms by the irradiation of Al and B with α-particles.

$$^{27}_{13}Al + ^{4}_{2}He \longrightarrow ^{30}_{15}P + ^{1}_{0}n$$
$$^{30}_{15}P \xrightarrow{3{\cdot}2\text{ min.}} ^{30}_{14}Si + e^{+}.$$

$$^{10}_{5}B + ^{4}_{2}He \longrightarrow ^{13}_{7}N + ^{1}_{0}n$$
$$^{13}_{7}N \xrightarrow{14\text{ min.}} ^{13}_{6}C + e^{+}.$$

They succeeded in separating the radio-phosphorus and radio-nitrogen by chemical means from the mother substances and thus definitely established the mechanism of the reactions. In the first case aluminium after irradiation was treated with caustic soda; the liberated gas was found to be radio-active. In the second case, where boric acid was used as the target, the latter was heated in air; the evolved gases were treated with metallic calcium after purification by pyrogallol, calcium chloride, etc.; the activity was found with calcium. The latter, on treatment with water gave out ammonia which was found to be active.

This was soon followed by the discovery of many similar other processes by these and other investigators. Moreover, processes were found in which artificially active body emitted no positron but β-rays or electrons. In other words, it changes into an element of higher atomic number.

But this Curie-Joliot process in which primarily an α-particle is captured and a neutron emitted, is effective only with lighter elements, *i.e.*, in cases where the repulsive force of the nucleus on the α-particle is not very great. The heaviest elements undergoing disruption by this process are potassium (19) and calcium (20). Similar results were obtained also by the use of artificially produced positive rays like fast protons and deuterons.

A great service has, however, been rendered to the development of nuclear chemistry by the Italian physicist Fermi and his co-workers by employing uncharged neutral particles neutrons—in place of the charged ones for atomic disruption. In a very short time this new process has furnished us with radio-active isotopes of almost all chemical elements up to uranium. No potential barrier exists for the entrance of the uncharged neutrons into the atomic nucleus.

Sources of neutron for the production of artificial radio-elements are furnished by a mixture of radium or radium emanation and finely powdered beryllium sealed into a glass tube. The neutrons arise by the reaction

$$^{9}_{4}Be + ^{4}_{2}He \longrightarrow {}_{6}C^{12} + {}_{0}n^{1}.$$

They pass practically unchanged through the glass.

There are three types of nuclear reactions set up by the neutrons:

I. (*a*) $^{27}_{13}Al + ^{1}_{0}n \longrightarrow ^{28}_{13}Al \xrightarrow{2{\cdot}3\text{ min.}} ^{28}_{14}Si + \bar{e}$

(*b*) $^{27}_{13}Al + ^{1}_{0}n \longrightarrow ^{27}_{12}Mg + ^{1}_{1}H$, $\quad ^{27}_{12}Mg \xrightarrow{10\text{ min.}} ^{27}_{13}Al + \bar{e}$

(*c*) $^{27}_{13}Al + ^{1}_{0}n \longrightarrow ^{24}_{11}Na + ^{4}_{2}He$, $\quad ^{24}_{11}Na \xrightarrow{15\text{ hours}} ^{24}_{12}Mg + \bar{e}$

starting from the same element, three different elements are produced.

II. (*a*) $^{23}_{11}Na + ^{1}_{0}n \longrightarrow ^{24}_{11}Na \xrightarrow{15\text{ hours}} ^{24}_{12}Mg + \bar{e}$

(*b*) $^{24}_{12}Mg + ^{1}_{0}n \longrightarrow ^{24}_{11}Na + ^{1}_{1}H$, $\quad ^{24}_{11}Na \xrightarrow{15\text{ hours}} ^{24}_{12}Mg + \bar{e}$

(*c*) $^{27}_{13}Al + ^{1}_{0}n \longrightarrow ^{24}_{11}Na + ^{4}_{2}He$, $\quad ^{24}_{11}Na \xrightarrow{15\text{ hours}} ^{24}_{12}Mg + \bar{e}$

Same element results from three different sources.

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The unstable artificial radio-elements, thus produced, emit β-rays and change into the stable next higher element, whereas the artificial radio-elements produced by positively charged proton, deuteron and α-particles generally emit positrons and change into the stable next lower element. The possibility of one or the other of the above three types of neuclear reactions being induced by neutrons deepnds on the velocity of bombarding neutrons and the nature of the irradiated element. Processes (*b*) and (*c*) are more frequent with fast or energetic neutrons and with relatively lighter elements; otherwise the corpuscular rays cannot leave the field of their mother atoms. The process (*a*) occurs only with slow neutrons in the case of lighter elements and with both fast and slow neutrons in the case of heavier elements, but even then much intensified by the slow neutrons. The slow neutrons can hang about the nucleus more easily than the fast ones.

A simple method of slowing down the neutrons consists, as shown by Fermi and his co-workers, in passing them through hydrogen containing substances like paraffin or water.

Most of the artificial radio-elements have very short life and hence readily break down into stable elements. There are, however, few whose lives extend over days, weeks and months. The amount of the active element, artificially generated, is always insignificantly small. They are, therefore, detected and identified mostly by their radioactive properties, *e.g.*, by β-ray electroscope, Wilson Chamber and most conveniently by Geiger-Müller Counter. In many cases the result has been confirmed by chemical separations followed by activity measurements.

The question then naturally arises—what is the practical significance of these artificial radio-elements and to what addition to our knowledge they may be expected to contribute? Leaving aside their great importance in the physical investigation of nuclear structure, to us, the chemists, they furnish extraordinariry sensitive tests for the detection of chemical elements. They may thus be used as radioactive indicators for the detection of almost all elements.

The limit of sensitivity of a micro-test lies at or about 10^{-8} gm. or 10^{-2} γ. 10^{-8} gm. Pb contains about 30 billion atoms. With radio-lead as an indicator lead can, however, be detected down to 10^{-17} gm. or even less; and with the help of physical methods, such as Wilson Chamber or Geiger-Müller Counter, detection can be made even of single atoms. These artificial radioelements, though generated in unweighable quantities, can be mixed with their inactive isotopes in any amount. The activity of the former can then be employed as an indicator for the latter. Like the natural radio-elements, these artificial radio-elements furnish us with a large store of materials for use in physical, analytical, preparative and geo-chemistry. A special use of them is likely to be found in bio-chemistry and medicine; *e.g.*, in the investigation of the circulation of physiologically important elements in animal and plant lives, or of the accumulation in healthy or diseased organs of physiologically active heavier elements. Some work has abready been carried out on these lines.

An instance of the use of artificial radio-elements in chemical examination may be described here. Radio-gold (T 65 hours) and radio-silver (T=22 Sec., and 2.3 min.) have been prepared by neutron bombardment (slow neutrons). A gold-silver alloy, when irradiated for a short time with slow neutrons will show only the rapidly decaying activity of radio-silver, by long irradiation the activity of both radio-silver and radio-gold. In the latter case the silver activity practically disappears after 20 minutes, whereas that of gold will continue for days. Hence it is quite easy to detect any adulteration of silver in an object made of gold by short irradiation with neutron. The object suffers absolutely no damage by this process of examination.

In the above case there was no necessity of separating the active product from its inactive isotopes. But in many cases, specially in the medical investigation of animal and human bodies it becomes desirable to obtain the active radio-element in as concentrated form as possible, almost in unweighable quantities free from other substances.

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For this purpose a large amount of the inactive substance is irradiated and from this the active isotope is separated almost in weightless amount by suitable chemical methods.

Szilard and Chalmers irradiated ethyl iodide by means of neutron after mixing it with a trace of free iodine. The free iodine was then reduced to hydriodic acid, the latter was precipitated by silver nitrate. The precipitate of silver iodide showed an activity 200 times greater than that of unconcentrated iodine.

The atomic weights of all these artificial radio-elements produced by neutron radiation are rather too high compared with their atomic number. Hence, they all emit β-rays and thereby increase their nuclear charge by one unit. The atom type, thus arising, is stable and does not change further. From radio-sodium arises the stable magnesium, from radio-magnesium the normal aluminium and so forth; from radio-gold arises the stable mercury and not otherwise, gold from mercury, as was previously believed.

But the matter becomes quite complicated when we arrive at the end of the Periodic Table; *i.e.*, when thorium or uranium are irradiated by neutrons. We are dealing here with already (naturally) active substances.

From thorium Meitner and Hahn have obtained isotopes of Th, Pa, Ra and Ac.

Still more complicated are the transformations with uranium. Fermi and his co-workers have shown that by irradiation of uranium by neutron four new radio-elements of half-life periods 10 Sec., 40 Sec., 13 min., and 100 min. are artificially produced. The latter two were chemically separated by them and believed to represent elements beyond uranium in the Periodic Table.

The subject has recently been fully investigated by Hahn and Meitner. As a result of their brilliant investigations they have been able to separate chemically the successive products resulting from uranium by irradiation with neutron.

The uranium was freed as far as possible from its natural disintegration product U by chemical separation before it was exposed to neutron. The irradiation was carried out for minutes, hours and days long, whereby short-lived and also comparatively more stable substances of longer life-period were obtained in increasing amounts. Chemical and electro-chemical separation of the products were made after the addition of different carrier substances, which led to a definite conclusion about the chemical nature of the active products. Measurement of activity was made by Geiger-Müller Counter.

From a study of the decay curve of the active products and by the various physical and chemical methods Hahn, Meitner and their co-workers have been able to establish the following three different transformation processes induced by neutron in uranium.

By slow neutrons.

$${}_{92}U + {}^{1}_{0}n \longrightarrow {}^{235}_{90}Th + {}^{4}_{2}He$$

$$\xrightarrow{\beta} {}^{235}_{91}Pa \xrightarrow{\beta} {}^{235}_{92}U \xrightarrow[23\ \text{min.}]{\beta} {}^{235}_{93}\text{Eka-Re.}$$

By both fast and slow neutrons, but promoted by slow neutrons.

II. $${}^{238}_{92}U + {}^{1}_{0}n \longrightarrow {}^{239}_{92}U$$

$$\xrightarrow[10\ \text{sec.}]{\beta} {}^{239}_{93}\text{Eka-Re} \xrightarrow[2.2\ \text{min.}]{\beta} {}^{239}_{94}\text{Eka-Os} \xrightarrow[59\ \text{min.}]{\beta} {}^{239}_{95}\text{Eka-Ir} \xrightarrow[66\ \text{hours}]{\beta} {}^{239}_{96}\text{Eka Pt} \xrightarrow[2.5\ \text{hours}]{\beta} {}^{239}_{97}\text{Eka-Au}$$

By fast neutrons only.

III. $${}^{238}_{92}U + {}^{1}_{0}n \longrightarrow {}^{237}_{92}U + 2\,{}^{1}_{0}n$$

$$\xrightarrow[40\ \text{sec.}]{\beta} {}^{237}_{93}\text{Eka-Re} \xrightarrow[16\ \text{min}]{\beta} {}^{237}_{94}\text{Eka-Os} \xrightarrow[5.7\ \text{hours}]{\beta} {}^{237}_{95}\text{Eka-Ir.}$$

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Since by successive β-ray changes the atomic number continually rises with atomic weight remaining constant, a reverse process may finally intervene in which with α-ray emission the atomic number will be reduced again. Such α-ray emitters will, as could be expected, be relatively longer-lived elements, the proof of whose formation can possibly be obtained by long irradiation with much more powerful sources of neutron than hitherto available.

The artificial production of elements Nos. 93, 94, 95, 96 and 97 shows that our Periodic Table can be extended not only to the Eka-Pt of pseudo-stable electronic structure resembling platinum but even beyond to Eka-Au. Its normal termination should, however, occur in another inert gas Eka-Radon, which would be a homologue of Radon. Whether any further extension will be possible or the process will be reversed with expulsion of α-particles, protons or positrons before we can arrive at Eka-radon, only future investigation can prove. We should now wind up with the happy feeling that man has been able to extend nature's creation in this process of building up of elements.*

* From a lecture delivered before the Science Society of the Benares Hindu University March, 1938.

Our Rebel Collection

To those of our readers who admit an interest in the odd and unusual, as exhibited in the workings of the human mind, we have often thought of revealing one aspect of an editor's duties for which no corresponding evidence appears in the published periodical. Arriving with the manuscripts that are considered seriously for publication are usually to be found a few which, could they but be published, might provide the readers—or at least those of them having curiosity about curiosa almost as much return in entertainment, even if not of value, as the more dependable information regularly presented. These are the scientific hypotheses of the studiously unorthodox. All men of science frequently receive such hypotheses from those who are in rebellion against what they term "orthodox science," but the editors of journals of popularized science probably receive more than any scientist—unless it be Professor Einstein, who recently told us that one of his biggest problems was to sort his worthwhile mail from this kind of communications.

It seems to be almost nothing for a man without much scientific training to sit down and solve the subtlest secrets of the universe—the nature of matter and of life, for example— in a single session. Failing to obtain publishers after trying all magazines, they do their own publishing, and thus for many years we have been receiving curiosa, both pamphlets and books: "Newton's Law Disproved." "The Riddle of the Universe Solved." "Rex Rays -the Great Discovery." "Avity, the Secret of Gravity." These are but four—we could go on naming them to a pageful. But for a sense of detachment and perhaps of humor, these offerings, usually attacking prominent scientists with venom, might jaundice an editor's life. Instead, we collect them!

Years ago, when starting this collection, we wondered whether it would not pay science to deputize a scientist to examine them all, in hope of finding occasional pay-dirt. To-day we believe we were wrong. Instead, we hope to deposit them permanently in some university library of the history of science. Future historians might otherwise judge that, in our era, pseudo-science was already extinct.

—*Scientific American*

Notes and News

New Museum at Nagarjunokonda

Nagarjunokonda in the Madras Presidency is a place of much archæological importance, as revealed by the excavations carried out there by the Archaeological Survey of India. A number of monasteries, temples, stupas, inscriptions, coins and large collections of magnificent bar reliefs have been discovered there. The place bears the name of the great Buddhist savant who was among the earliest of the teachers of the Mahayana cult of Buddhism which is still in vogue in Tibet. The inscriptions found here show that its ancient name was Sri-Parbati, where Nagarjuna, according to Tibetan tradition, spent the latter part of his life, this leading to the complete identification of the place. Inscriptions belonging to the Great Stupa at Nagarjunokonda record that this monument had been consecrated by the deposit of a relic (*dhātu*) of Buddha himself. This relic was discovered in a tiny, round gold box, together with a few gold flowers, pearls, garnets and rock-crystal beads. It is now kept in the Mulagandhakuti-Vihara at Sarnath, near Benares. The Archæological Survey of India has now brought out on this subject a memoir, titled *The Buddhist Antiquities of Nagarjunokonda*, in two parts, written by A. H. Longhurst, formerly Superientendent of the Archæological Survey for the Southern Circle, and now Archæological Commissioner in Ceylon and Dr S. Paranavitana of the Archæological Survey of Ceylon. The book is properly illustrated, and describes in detail the finds at Nagarjunokonda.

The Government of India sanctioned a museum at this place for housing the remarkable series of reliefs found here, and the construction is nearing completion.

Tidal Predictions by Geodetic Survey

It is well known that the Survey of India have been bringing out a publication every year on the tide tables of the Indian Ocean. This publication is of great importance to those who navigate the seas. The predictions of the tides are made by the Geodetic Survey of India, with the help of a machine kept in the Survey office at Dehra Dun. It has an interesting history behind it. It was invented in 1872 by Lord Kelvin and first set up in the Indian Stores Department, Lamberth, and later on at the National Physical Laboratory, Teddington. In 1921 the machine was brought out to India, and ever since it has been there at Dehra Dun. It is used for the annual prediction of tides at 41 ports in the Indian Ocean three or four years in advance. The predictions are incorporated in the annual publication, as said above. It gives the times and heights of each high and low tide at 28 ports obtained from the other sources in addition to those for the 41 ports in the Indian Ocean predicted on the machine. What is done to get the predictions of tides at any port is first to record the height of the tide at any port throughout the 24 hours of the day for at least one year or preferably for several. This record is then mathematically analysed. Once the analysis of any port is completed, the machine is set in phase to run a tidal diagram enabling the tides at that port for any year to be predicted.

Haveli Irrigation Project

The Haveli irrigation scheme for which the Punjab Government recently raised a loan of Rs. 1,00,00,000, was originally estimated to cost Rs. 5,25,00,000. But the actual expenditure owing to several savings effected is likely to be much less.

The expenditure during 1937-38 was Rs. 64,50,000 out of which the Punjab Government met Rs. 45,00,000 from their own resources and the balance from the cash section of the loan raised last year. This year the expenditure is estimated to Rs. 1,50,00,000.

The Punjab Government are able to meet half a crore from their own resources and for the balance the loan was floated.

The project, when fully developed, will provide perennial irrigation to 500,000 acres and non-perennial irrigation to 450,000 acres in the Jhang, Multan and Muzaffargarh districts. The estimated net annual revenue ten years after the canals begin functioning and after paying working expenses is Rs. 43,00,000 which means a return of 8 per cent on the capital expenditure, but it will be more in view of the savings mentioned above.

The project, when completed, will add considerably to the prosperity of the province. The main canal is being lined with *pucca* masonry.

Progress on the construction of the Emerson Barrage, the headworks of the project, and other works has been remarkable. It is hoped to finish the work in about two years against an estimated period of five years.

Demand for Enquiry into the All-India Radio Rejected

In the Central Assembly a resolution was moved on August 10 last by Sardar Mangal Singh, which recommended the appointment of a committee with a non-official majority to enquire into the working of the All-India Radio. The public, it is agreed, is not satisfied with its working, and it is for the authorities to allay their suspicions, whatever they be, and satisfy them on this score. Though the supporters of the resolution made it clear that the resolution was not necessarily meant as a censure, but urged that an enquiry would serve to assure public opinion that a new department as the All-India Radio was proceeding along right lines of development It was opposed vehemently by the Government and their supporters and rejected. In our view these would have been a distinct gain, had such an enquiry been allowed to be made, and the results published to satisfy the public.

Changes in Electric Rates in Bombay

Under the Bombay Finance (Amendment) Act, 1938, the duty on electricity used for the purpose of lights and fans has been increased from 6 pies to 9 pies per unit from 1st April, 1938, in the City of Bombay and in the areas covered by the following licenses:—

(1) The Ahmedabad City Municipality and District Local Board Electric License.

(2) The Surat City Municipality and District Local Board Electric License.

(3) The Thana Electric License.

(4) The Bhiwandi Electric License.

(5) The Kalyan Electric License.

(6) The Poona Electric License.

(7) The Belgaum Electric License.

(8) The Bombay Suburban Electric License.

Government is pleased to note that in the areas in which the duty has been increased, the Supply Companies concerned have reduced their rates for supply with the result that the burden of extra taxation does not fall upon the consumers. In some of the areas a reduction in rates of even more than the three pies increase in duty has been made, still further benefiting the consumers. The supply companies have been wise in reducing the rate charged per unit of electricity of consumption in proportion to the increase of the duty imposed by the Government. We wish the Companies went a step further and make still larger reductions which cannot, we are sure, decrease their income, for such reductions will only increase the number of their subscribers, and therefore inflate it.

Improvement of Grazing and Fodder in Bombay

The All India Cattle Conference at its meeting held at Simla on 25th and 26th May, 1937, recommended that Standing Fodder and Grazing Committees should be established in all provinces on the lines suggested by the Board of Agriculture and Animal Husbandry in India. In pursuance of the recommendation of the Conference, the Government of Bombay have constituted a Provincial Fodder and Grazing Committee consisting of official and non-official members to examine and advise on all matters connected with the use and improvement of grazing, grass and fodder of all descriptions.

The Honourable Minister for Revenue, Rural Development and Agriculture, will be the Chairman and the Commissioner, Central Division, Vice-Chairman

of the Committee. The Livestock Expert and the Working Plans Officer, Central Circle, for the time being will work as Joint-Secretaries of the Committee and will be responsible for calling meetings and conducting the correspondence of the Committee.

The Committee will ordinarily meet twice a year and will have power to co-opt for any meeting any official or non-official persons whom it thinks fit.

The Committee will be a purely advisory body and its functions will be:—

(*a*) to arrange for a survey and classification of all lands in the Province which on account of climatic, topographic or economic reasons are best suited for management as pastures. This definition would include wooded pastures, true pastures and intermediate types and would provide for the inclusion in each, where necessary or desirable, of lands marginally or sub-marginally suitable for cultivation as being capable of carrying an occasional field crop but requiring long intervals either as fallow or under grass in order to restore fertility. In addition the *survey should include an estimation of the resources of cultivated fodder in the* different districts of the Province;

(*b*) to examine the incidence and adequacy of such lands and fodder resources throughout the Province in relation to the location and numbers of livestock essential for the proper economic pursuit of agriculture and livestock breeding;

(*c*) to ascertain the present ownership or sources of control over such lands and to examine the adequacy or otherwise of existing organisations for managing such lands on proper lines, and to make recommendations;

(*d*) to examine existing methods of management of such lands and to make recommendations for improved methods which might be adopted for the attainment and maintenance of the maximum production of fodder and grazing in the manner most useful to agriculturists and breeders of livestock;

(*e*) to consider all schemes for improvement of grass lands, rotational grazing experiments, fodder storage, etc.;

(*f*) to devise methods for making use of spare irrigation water for raising grass and other fodder crops.

The Committee will work through the Government departments and the district village improvement associations. Government would refer to the Committee cases for opinion and would, as far as possible, issue orders in the light of its opinion subject to financial considerations.

The function of the Provincial Agricultural Research Committee constituted by Government in conformity with the recommendation of the Royal Commission on Agriculture is to advise Government on programmes of agricultural research to be submitted to the Imperial Council of Agricultural Research on applications from persons within the Province for grants from that body and also on any scheme or project which may be referred to it by Government for opinion. The Imperial Council of Agricultural Research, however, considers that in cases where the Provincial Fodder and Grazing Committee may have any schemes of All-India importance to send up to the Council, it should not be necessary for such schemes to come through the *Provincial Research Committee. Such schemes of All-India importance will therefore be submitted to* Government direct by the Provincial Fodder and Grazing Committee for transmission to the Imperial Council of Agricultural Research.

Charges for Electricity

"The Truth About the Price of Electricity in the Home", is the title of a booklet published by the British Electrical Development Association. It gives the results of an independent survey by a Fellow of the Royal Statistical Society which show that more than 97 per cent. of the *domestic electrical consumers* of Great Britain can buy their electricity at 1*d.* a unit or less, that 60 per cent. of consumers can buy it at ½*d.* a unit or less and 85 per cent. of consumers at ¾*d.* a unit or less. It is pointed out that these prices are made possible by the all in domestic rate which has been adopted by the majority of electricity supply undertakings in Great Britain. These figures, which were the result of calculations based on the number of actual consumers who can buy at the different rates, were compared with data based upon the total number

of houses (whether connected to the mains or not) in the areas covered, and this survey gave practically as good results. This fact may be considered surprising, as in the latter case, many houses are included which are far from the load centres. It is said to be unlikely that any general increase in the selling price of electricity will be necessary because the cost of coal is a relatively smaller proportion of the total cost of production than with gas.

—*The Electrician.*

National Institute of Sciences of India

The symposium on 'Recent work on the synthesis of naturally occurring substances', under the auspices of the National Institute of Sciences of India will be held at Bombay on the 26th and 27th September, 1938. The programme of the meetings is as follows:—

Monday, the 26th September.

10-0 A.M.- 12-45 P.M.	Address by Dr J. N. Ray and reading of papers.	R. I. Sc. Room No. 32.
1-0 P.M.— 2-30 P.M.	Lunch . .	Mongini's Restaurant.
2 45 P.M.— 3-45 P.M.	Visit to the Department of Chemical Technology.	
4-30 P.M.— 6-0 P.M.	Formal Opening of Symposium by the Vice-Chancellor of the Bombay University.	Sir C. J. Hall (University.)
6-30 P.M.	Public lecture by Dr S. S. Bhatnagar on 'How Chemistry can help Indian Industries.'	Sir C. J. Hall (University.)

Tuesday, the 27th September.

10 0 A.M.- 12-45 P.M.	Reading of papers	R. I. Sc. Room No. 32.
1-0 P.M.— 2-30 P.M.	Lunch . .	Mongini's Restaurant.
2-45 P.M.— 4 30 P.M.	Business meeting and reading of papers.	R. I. Sc., Room No. 32.
4-30 P.M.— 5-15 P.M.	Tea by Dr K. B., A. K. Turner, President, Indian Chemical Society, Bombay Branch.	R. I. Sc., (Library.)
5-15 P.M.— 6-15 P.M.	Lecture by Prof. J. C. Ghosh.	Sir C. J. Hall (University.)
6 30 P.M.	Public lecture by Dr M. N. Saha, F.R.S., on 'Geography of Space.'	Sir C. J. Hall (University.)

A Basis for World Peace

We are glad that a number of distinguished men of Science- amongst others Sir A. S. Eddington and Sir F. Gowan Hopkins—have been trying to work out 'a basis for world peace' and has issued the following circular letter: -

A number of distinguished men and women—representative of the Church, Science and Letters, Heads of Universities and Colleges, and others—have expressed their approval of the principle for world peace. The Governments of different nations have become entangled in a net-work of suspicion; fear of one another has driven them to place their ultimate, if not their sole, reliance upon force. In these circumstances the most hopeful course of action is to seek to remove the grounds for suspicion by raising the problem of international relations on to a higher plane. Many people in every country feel strongly that the arbitrament of force—at best a confession of failure—can be and must be avoided. They look eagerly to those who are capable of leading opinion to secure a return to reasoned discussion on the part of all nations, whether they be at war or at peace. Even to those at peace, if it be a peace that is only a preparation for war, burdened as they are with the heavy cost of armaments and with an ever-present anxiety about what is to come, progress in the things that really matter is blocked.

There is therefore under consideration the possibility of forming a World Foundation of people of good faith who accept, and are prepared to do what they can to promote, the principle here formulated as the only trustworthy guide to action on the part of our own and every other responsible Government. The Foundation would be essentially *a league of peoples, not of Governments*, but it would seek to co-operate with and so strengthen any Government and any organization working along the same lines. True to its supernational character, its main purpose would be to devise and advocate ways of translating its fundamental principle into concrete action.

NOTES AND NEWS

As an illustration of the sort of action contemplated, the British Government might be encouraged to carry its conversations with other Governments a stage further. *All might be invited to join in setting on foot an expert and impartial survey of the wealth of the world. If we are to seek to satisfy the basic needs of* every nation upon terms that are recognized as reasonable and just, it is clearly necessary to begin by ascertaining as accurately as possible the nature and extent of each country's resources in land and people, in raw materials and technical equipment, and any potential outlets there may be for surplus populations. Much has been done in this direction already by the League of Nations, the Royal Institute of International Affairs, and other responsible bodies. Again, if international trade is to prosper and adequate provision is to be made for a rising standard of life, especially in backward countries, steps must be taken sooner or later to remove the accumulated restrictions upon the flow of commodities. Here M. van Zeeland, in his valuable report on economic collaboration, has made proposals which merit the serious attention of statesmen.

Leaders of thought in different fields would be capable of promoting the objects of the World Foundation in very different ways, and it would therefore be wise for each distinct group to form its own separate section, controlled by its own officers and executive committee. Scientists, for instance, might form one section, Writers another, Heads of Universities and Colleges another, and so on. Such a formation would have the additional advantage that the members of each section would know and could establish contact with workers in the same field in other countries. But all sections should be linked together, however loosely, seeing that all would be pursuing the same end in their several ways; and from time to time representatives from each might confer in regard to united action for certain common purposes. By this plan associated nuclei of thinking men and women would be formed throughout the world, capable, by concerted action, of bringing powerful influence to bear upon the course of international events.

It would be fitting that scientists, many of whom feel a deep concern on account of the evil uses to which their researches are sometimes put, should take the lead by forming a scientific section of a World Foundation on these lines. Other groups might well follow their example. The development of the scheme will depend entirely upon the measure of encouragement it receives, and the purpose of this communication is to test feeling among British scientists. Assuming it receives adequate encouragement, an opportunity for the discussion of the *tentative suggestions here made, and related matters of* importance, will be arranged by means of a Conference at an early date.

We are entirely in accord with the noble sentiments expressed in the above circular letter, and hope that the Angel of Peace would be able to overcome the Demon of Strife. As many of the promoters of the organization have visited India as delegates to the Silver Jubilee Session of the Indian Science Congress, they must have acquired some first hand knowledge of the conditions of life in India. We hope they need no argument to be convinced that India is a backward country, and the standard of life must be substantially raised—at least eight or ten times its present economic life. They have also noticed that India possesses in her scientists, a band of men actuated by sentiments of work and service to the country. Probably the delegates might have also grasped why India continues to be poor, while her soil is rich and resources almost unlimited. We hope that consistently with the noble sentiments expressed here, they will preach *practical* benevolence to their statesmen and politicians in matters dealing with India.

SCIENCE IN INDUSTRY

Growth of Indian Tea Industry

"Capable of producing over 500 million pounds of tea, there is a capital invested in India's tea industry to the tune of some Rs. 97 crores," according to the chairman of the Indian Tea Market Expansion Board in his broadcast talk. "The export trade in tea from India was only 235,000 lbs. in 1853 but today it is of the proportion of 334.7 million lbs. annually, representing a value of Rs. 24.38 crores."

"Tea is a bush plant which if allowed to grow uncared for would reach the dimensions of small trees. Planted as a seedling in the nursery, carefully tended and then transplanted to the main garden with hundreds of thousands of others, it is allowed to grow unchecked — all weeds and such like jungle growth alone being checked to permit of its receiving the greatest nourishment from treated soil—until such time as it receives its first pruning. This is a process which varies from district to district and even from garden to garden. The main object is, however, the same: to keep the plant at a reasonable height and to stimulate the growth in the correct manner so that the best production may result. Hundreds of women are then employed in the process of plucking the leaves and, generally speaking, only the bud and the first two leaves are taken from each stem, though the third somewhat coarser leaf may also be harvested. These leaves are collected by the pluckers in baskets and removed to the factory where they undergo four principal processes: withering, rolling, fermenting and firing.

"Your tea is, however, not yet ready for despatch to you: it must be sorted and graded, processes carried out by hand and by machines so as to separate it into different sizes and qualities to suit the various markets and blenders. It is then packed in chests and forwarded from the garden to the various markets of the world where it is tested by those who are expert in placing a value which the planter should receive on the tea he has produced; purchased by big dealers in tea who employ men to blend it to suit the needs of your particular requirements; and then sold in packets or in tins in its final state before it enters your teapot.

"Tea is a product which has limitless bounds in its distribution: it is one which in its development and manufacture is a triumph of industry, science, and business enterprise, bringing prosperity to millions and making the teapot the symbol of comfort and refreshment in homes all over the world."

The Working of the Indian Cane Factories

The working results of Modern Cane Factories for the season 1937-38 are now available. The total production of sugar by the factories in India for the season 1937-38, according to the estimate of the Indian Sugar Mills Association comes to 923,650 tons as against the actual production of tons 1,111,400 for the season 1936-37. This figure is based upon actual returns received by the Association from more than 90% of the factories working for the season while the figures in respect of the remaining few factories have been estimated either on the figures of cane crushed, wherever available, or on their daily crushing capacity and the number of days worked. The decline in the production of sugar during the last season as compared to the previous season was due to the shortage of cane supply in several districts. The season was of a shorter duration, the factories having worked on an average for 114 days only as compared to 144 days during the previous season. The season was particularly short in Bihar where the factories worked only for 100 days on an average as against 155 days in the previous season. The recovery of sugar during the season 1937-38 was 9.29% whereas *the final figure for the previous season was 9.50 percent.* The low recovery might be attributed to the *inferiority*

of cane and the prevalence of cane diseases in various parts of U.P. and Bihar. The production of sugar by factories in Burma for 1937-38 has been estimated at Tons 26,850 against the actual production of Tons, 17,550 during 1936-37.

Protection Urged for Sericultural Industry

The sericultural industry which has developed in various parts of the country principally in Bengal, Mysore, Assam and Kashmir is esentially a rural industry. In Bengal before the onset of depression there were 33,451 rearers and 17,555 acres under mulberry. By 1933-34 the number of rearers had fallen to 18,592 and the mulberry area to 10,032 acres and in 1936 37 the number of rearers and acreage under mulberry stood at 15,180 and 9,448 respectively. In other parts of the country also the same tendency was the main reason for the set-back the industry has suffered during the past several years. According to a communication addressed to the Tariff Board by the Committeee of the Indian chamber of commerce, the most important factor on account of which such uneconomic prices prevail was the competition of foreign countries. In 1931-32, the Committee point out, raw silk worth Rs 62,27,467 was imported into India from China and Japan and this increased to Rs 94,67,262 in 1937-38. Moreover, the import of artificial silk, an indirect competitor of raw silk, rose from 11,000,000 lbs. in 1932-33 to 17,000,000 lbs. in 1937-38. In the face of such severe foreign competition indigenous industry has hardly been able to subsist. The Committee refer to the Report of the Department of Industries Bengal, and state that the fact that the industry exists in such hard times of competition is mainly due to the profession of silk worm rearing being pursued by labour which was otherwise unproductive and would have remained unemployed.

The Committee refer to the various improvements effected in the industry during the past few years and state that sufficient time should be allowed to the industry to reap the benefits of the improvements. As emphasized by the Committee in view of the important place the industry occupies in the rural economy of the country, the existing protection to the industry should be continued for a further period of ten years.

Our Industrial Article for September

The article on the Manufacture of Synthetic Ammonia and Nitrogenous Fertilisers has been contributed by Mr N. G. Chatterjee of the Harcourt Butler Technological Institute, Cawnpore for our Section of Science in Industry of the present issue of the Journal.

The Manufacture of Synthetic Ammonia and Nitrogenous Fertilisers

N. G. Chatterjee
Harcourt Butler Institute, Cawnpo

It is an established fact that Indian soils are very deficient in nitrogen, so that a matter of primary importance for agricultural improvement in the country is a plentiful supply of indigenous fertilizers. The natural supply of the latter from indigenous sources is very limited, and hence the use of synthetic compounds imported from abroad has of late been rapidly growing.

Almost every country in the world has been developing the nitrogenous products industry, and on account of its immense national importance, it is the one essentially chemical industry which has been subsidized lavishly by the State. Of course, the primary reason for State help to establish the industry has been not so much to produce fertilizers as to secure a plentiful supply of munitions in times of war, for explosives are mostly nitrogenous compounds. This point is of great importance and must be carefully borne in mind when

considering the economic aspects of the industry in India, for there is every likelihood of objections being raised to show that the cost of production of synthetic ammonia and its compounds would be in excess of the cost at which they could be imported. But such objections should be brushed aside on account of the fact that the products of these explosive munition factories are in reality being dumped into other countries in order to keep the plant in an efficient state of working during peace time, and that therefore the export prices of these products fixed by the various countries are in most cases below their legitimate cost of production according to established rules of works accountancy.

Some of the Provincial Governments are now seriously considering the establishment of some large-scale industries with active help of the State. It is submitted that the synthetic nitrogenous products industry ranks first in merit in this respect, for, on the one hand, the products are of national importance both in time of peace and war, and, on the other, it is of such a nature that purely private enterprise is neither sufficient nor desirable to establish the industry.

The conditions in the United Provinces and also in Chotanagpur are quite favourable for the establishment of this industry. The hydro-electric power available in the Western area of the U.P. may form the nucleus in devising a working scheme for the establishment of a small composite chemical works, producing electrolytic caustic soda, and using the hydrogen evolved to manufacture synthetic ammonia and ammonium compounds.

In Chotanagpur, due to the coal fields, the conditions are very favourable for the establishment of a central national nitrogenous fertilizers factory, producing hydrogen from coke by the "iron-contact process" and utilizing the nitrogen of the air by liquefying the latter.

The requisite plant has already been standardized by various manufacturers, and their successful operation may now be guaranteed.

A preliminary idea about the importance of the industry so far as India is concerned may be had from a perusal of the note attached. In case Governments feel sufficiently interested, detailed investigations may then be taken up.

Outlines of the Process of Manufacture of Nitrogenous Fertilizers by the use of Synthetic Ammonia

In Germany the first ammonia synthesis was successfully carried through by the Badische-Anilin and Soda-fabric according to the process of Prof. Haber. The first plant was erected in 1913 and a year later this was extended to much greater capacity. Together with the output of the Leunaworks of the same company (now the I. G. Farben industries A. G.) about 400,000 tons of nitrogen are now produced in Germany in the form of nitrogenous fertilizers, nitrates, etc., per annum.

During and after the War, the synthetic process of "Claude" was developed in France; in Italy at the same time research took place and the process of "Casale" and "Fauser" were developed, and in America the process of the Nitrogen Engineering Corporation. In the main these processes differed from one other only in the size of units and the pressure and temperatures used. Naturally, the catalysts over which the hydrogen and nitrogen are led also vary in the different processes. The capacity of the plant depends largely on the method employed, and the nature of the catalysts. The smallest economic capacity of the "Haber" process is many times greater than that of the other, so that this process can only be considered for large units.

In general the cycle of operation of these processes is as follows:-

Hydrogen and nitrogen in the proportion of 3 : 1, are mixed at a certain temperature and under a pressure of about 100 atm., and are then led through a catalyst. There they combine to from ammonia (NH_3), which is produced either in the form of liquid ammonia or ammonia solution. As only partial reaction takes place repeated circulation of the ammonia in the apparatus is necessary in order to produce the required concentration. Therefore this process can be considered as a completely continuous process. The gases used, *i.e.*, hydrogen and nitrogen, must be of great purity to avoid damage to the catalyst. The produced ammonia is in the form of gas in this state is subjected to further treatment.

As previously stated, the "Haber" process is advisable for large-size plants. The units of other processes have a capacity of 7½-10 tons per day and are recommended in cases where only a small production of nitrates or nitrogenous fertilizer is required. Synthetic ammonia produces about 3 times its weight

of concentrated nitrates. The plant (*i.e.*, the nitrogen factory) can be operated to produce only a small amount of concentrated nitrates per day, so that individual plants can manufacture synthetic ammonia either for stock or for immediate use in producing nitrogenous fertilizer.

For the synthetic process, as far as is possible, pure hydrogen and nitrogen are required. For the production of hydrogen various processes are used. If electric power is cheap and is available in sufficient quantities, hydrogen can be produced by the electrolytic process.

If electric power or any other cheap power is not available, hydrogen can be suitably produced by the iron-contact process.

With this process iron-ore is used to disintegrate steam into hydrogen and oxygen. The oxygen of the steam oxidizes the glowing iron-ore, while the hydrogen leaves the apparatus in the form of gas. The method of operation of such plants is intermittent, *i.e.*, after oxidizing with steam, the oxidized ore or metallic iron must, by means of a reducing gas (which can either be water gas or coke oven gas), again be reduced to metallic iron. When this reduction has taken place the iron-ore content of the shaft is again suitable for the disintegration of steam, *i.e.*, the production of hydrogen. In consequence of the special construction of the catalyst chamber the iron-ore content is retained by the simplest method continuously at the reaction temperature.

The nitrogen is produced by means of an apparatus which operates on the principle of the liquefaction and separation of the constituents of air by diffusion. The apparatus consists mainly of the liquefaction and separation plants, the compressing plant and the apparatus for cleaning, drying and pre-cooling the air.

The hydrogen and nitrogen produced by the above-mentioned plants are now transformed by synthesis into ammonia. Of this ammonia the pure water-free ammonia must be further treated either for the production of nitrogenous fertilizer or for concentrated nitric acid, while the liquid ammonia produced in the ammonia synthesis is led to intermediate tanks and from these into an evaporator in which, by means of a piping system, it is heated by water and boiled. The ammonia vapours leave the evaporator and go from there into the pressure apparatus, in which they receive the small additional pressure necessary for filling the gas holder. This holder is specially constructed for receiving the ammonia gas and is provided with a heating apparatus as well as an indicator. The evaporated ammonia produced is now transported either direct into nitrogenous fertilize (for example, ammonium sulphate) or is burnt for the production of nitric acid, ammonium nitrate, sodium nitrate or calcium nitrate, or can put in cylinders in the anhydrous condition for use in factories. For the sake of clearness it should be stated that the production of ammonium nitrate evaporated ammonia is required. The ammonia gas is by means of an exhauster sucked out of the ammonia gas tank, the connection between the exhauster and the tank being a cast iron piping system of the necessary size. The exhauster delivers the ammonia gas by means of a similar cast-iron piping system to the mixing chamber in which it is mixed with purified air in a defined proportion. This mixture of air and ammonia is now led to an apparatus made of aluminium, in which it is burnt over a catalyst. There now exists a hot mixture of nitric oxide, steam oxygen and nitrogen, which is led over a heat exchanger plant to the condensation plant. The nitrogenous gases now go to a re-cooler which consists of coolers and internal spraying towers of acid-resisting metal. There the actual condensation and absorption take place. As a certain amount of heat is formed by the oxidation of the nitric oxide and by the solution of nitric acid in the water, the used acids for spraying the towers are cooled between the towers. The flow of the acids from tower to tower takes place by means of pumps of acid-resisting metal. The distributing apparatus and the ample filling of the towers ensures complete washing of the gases by the syraying liquid. The final product is a nitric acid of 33-36° which is stored in stone receptacles.

Concentrated Nitric Acid

There now remains to concentrate the nitric acid already produced. For this purpose, it is mixed with approximately double the amount of concentrated sulphuric acid and the mixture passes down the tower in uni-flow, whereas the steam passes upwards in counter-flow. The concentrated sulphuric acid absorbs water and condensed steam. The nitric acid leaving the tower is condensed and cooled and is discharged into store tanks as 37-38% pure acid.

The other products that may be made are (*a*) Ammonium Sulphate, (*b*) Ammonium Nitrate, (*c*)Sodium Nitrate, (*d*) Calcium Nitrate.

Below we give for the information of the reader

the statistic of the import into India of some nitrogenous chemicals and fertilizers during 1936-37.

Article.	*Quantity.*	*Value.*
Nitric Acid ..	2,275 cwt.	Rs. 26,771
Anhydrous Ammonia ..	2,760 „	„ 309,059
Carbonate and Bicarbonate of Ammonia ..	10,812 „	„ 1,82,897
Nitrogenous Manures—		
(*a*) Ammonium Sulphate ..	61,238 tons.	„ 58,43,656
(*b*) Ammonium Phosphate ..	4,122 „	„ 6,14,587

Scheme of a National Central Factory

Now we proceed to give the outline of a scheme for the manufacture of synthetic ammonia and fertilizers in a National Central Factory in this country.

Location of the Factory.- The Factory is to be erected in the coalfield area of Chotanagpur, the exact location being chosen after due consideration of the marketing conditions and proper shelter from aerial attacks.

Products to be Manufactured.—The basic product of manufacture would be synthetic ammonia, which is the starting point for making nitric acid required for explosives, and for ammonium sulphate for agricultural purposes (fertilizers). Ammonia is also an important raw material for making urea which is being used as a fertilizer and also for synthetic resins. In short, the factory is to be the central point in the national defence scheme of the country in time of war, and in national prosperity in agriculture and industries in time of peace.

The chief raw material would be coal, which would be subjected to a variety of preliminary treatment in order that it may be utilized not only in the most efficient manner, but may also have the potentialities of future expansion in the synthetic chemical industries from high pressure gas reactions. Hydrogen required for synthetic ammonia would be prepared from coke, and nitrogen would be obtained from liquid air.

Capacity of the Plant.—It is proposed to have a plant for producing 10 tons of ammonia per 24 hours. If the whole of this be converted into ammonium sulphate, the quantity of the latter would be about 14,000 tons per annum.

Requirements of Raw Material and Powder

PER TON NETT OF AMMONIA

1.	*Fuel.* (*a*) Coke for hydrogen generation	2·0 tons.
	(*b*) Coke for steam generation, etc.	1·3 tons.
2.	*Power.* Total	3,300 H.P.H.
3.	*Water* Total	30,000 Cu. ft.

PLANT COSTS.

1.	*Ammonia Section*		Rs. 23·10 lakhs.
	(*a*) Gas manufacture ..	Rs. 6·50 lakhs	
	(*b*) Compression & purification ..	„ 6·75 „	
	(*c*) Ammonia process ..	„ 6·10 „	
	(*d*) Plant facilities	„ 3·75 „	
	Total ..	Rs. 23·10 lakhs	
2.	*Power Section*		Rs. 3·50 lakhs.
3.	*Acid and Sulphate Section* ..		„ 4·50 „
	Total Physical Plant costs ..		Rs. 31·10 lakhs.
4.	*Overhead costs (during construction)*		„ 3·00 „
	Total Plant costs		Rs. 34·10 lakhs. or say Rs. 35 lakhs.

CAPITAL INVESTMENT

On Plant..	Rs. 35·00 lakhs.
Working Capital	„ 5·00 „
	Rs. 40·00 lakhs.

FIXED CHARGES

1.	*On Plant.*	
	Depreciation at 5% on Rs. 35 lakhs	Rs. 1·75 lakhs.
2.	*On Invested Capital.*	
	Interest at 5% on Rs. 40·00 lakhs	„ 2·00 „
	Taxes and Insurance at 2% ..	„ 0·80 „
	Total fixed charges ..	Rs. 4·55 lakhs.

or, per ton of ammonia Rs. 130.

AMMONIA PRODUCTION COSTS

Per ton of ammonia.

(In this is included the fixed charges, overheads,

maintenance, etc., on account of investment on the synthetic section.)

Process operation	..	.. Rs. 136
General plant expense	..	.. „ 34
Running maintenance	..	.. „ 54
Miscellaneous and Contingency		.. „ 21
Total operating costs		.. Rs. 245
Total fixed charges		.. „ 130
Total production cost		.. Rs. 375

Total production cost of synthetic ammonia is estimated to be about Rs. 375 per ton.

The production cost of ammonia sulphate may be estimated by adding the raw materials cost of sulphuric

Cost of production in other countries.

Reliable information is very difficult to obtain, but from data published in verious scientific journals, the cost appears to be near about the same as given here. It need however be hardly pointed out that accountancy methods are to a large extent responsible for any marked departure from this normal figure. Further, the recoginzed policy in the ammonia trade has been to market ammonium sulphate at cost price or even lower, in order to dispose of the surplus ammonia that cannot be sold in any other form.

Production of Ammonium Sulphate (Synthetic and by-product)

In metric tons (000's omitted)

	1931	1932	1933*
India .. (only by-product)	12	10	10
Japan ..	393	460	471
Germany ..	1,244	965	..
United Kingdom ..	532	638	584
United States ..	446	261	308

World Production and Consumption of Nitrogen

In metric tons (000's omitted)

	1932-33	1933-34	1934-35
Production			
Ammonium Sulphate	817·7	841·8	835·7
By-product ..	257·7	307·1	315·9
Synthetic ..	560·0	534·7	519·8
Calcium Cyanamide	168·5	195·2	238·5
Nitrate of Lime ..	118·2	107·2	153·1
Chile Nitrate ..	70·8	84·3	178·4

* Later figures are not available for all the countries.

World Production and Consumption of Nitrogen

In metric tons (000's omitted)

	1932-33	1933-34	1934-35
Production			
Other forms of Nitrate ..	501·7	563·8	635·7
By-product ..	39·6	48·3	44·4
Synthetic ..	462·1	515·5	591·3
	1,676·9	1,792·3	2,041·4
Consumption			
Manufactured Nitrogen	1,619·7	1,714·0	1,836·5
Chile Nitrate ..	127·2	163·6	194·4
Total Consumption	1,746·9	1,877·6	2,030·9
Of which Agricultural	1,586·0	1,673·0	1,792·0

—From *Statistical Year Book of the League of Nations*, 1935-36

Medicine and Public Health

Recent Researches on Surgical Complications of Filariasis

Next to Malaria, Filarial infection is the most wide-spread disease in certain parts of India. Although the rate of mortality is not as high as in Malaria, the amount of disability and suffering is enormous. Much work has been done at the school of Tropical Medicine in Calcutta and elsewhere on the medical and surgical complications of filariasis. Filarial diseases are generally characterised by the formation of varicosity of the lymphatics and oedema and fibrosis of the extremities. In all these cases the initial damage to the lymphatic system is brought about by the parasites, secondary infection aggravating the disease. Cases are, however, known where the pathological process is due solely to the parasite without any evidence of secondary infection. As no satisfactory specific for filarial infection is known at present, surgical treatment has often to be resorted to, particularly, in cases of lymph-scrotum, hydrocele, epididymo-orchitis and elephantiasis.

In this connection, the recent investigations by Mr P. N. Ray, M.B., F.R.C.S. (Eng.) on chronic epididymo-orchitis are specially interesting. In a paper read in 1933, at a clinical meeting of the British Medical Association, Clacutta Branch, he demonstrated with the aid of microscopic sections and slides the pathological changes which are seen in the typical case.[1] Sections of the adult female worm (*Wucheraria bancrofti*) and numerous microfilariae contained within the uterus, were seen both in the testes and epididymes. In these cases no evidence of secondary pyogenic infection could be seen. The conclusion was reached that the adult filaria was the real cause of the pathological changes in the testicle and the epididymis. Further work carried out on this subject at the Calcutta School of Tropical Medicine and by Mr Ray on 'filarial infections of the male genital tracts'[2] confirmed these findings. Detailed references to this important work may be found in some recent English works on Surgery dealing with the diseases of the male genital tracts.[3]

—*S..S..R.*

The Climatic Sanatorium

At one time it was the fashion all over the world to send tuberculous patients to a good climate for the cure. With the advancement in the methods of treatment it is justifiably realised now that good and adequate medical treatment is far more important than climate treatment alone. Yet the value of climate, though very much overrated in those days, is still recognised. Tuberculosis is a wasting disease with a very prolonged course even when the patient is proceeding towards recovery. It is why a climatic sanatorium affords many advantages to such a patient. A Sanatorium is generally situated at a high altitude which raises the metabolism of the body. The body, therefore, could be better nourished. The daily and seasonal variation of temperature, the dampness of the place etc. are generally less than the plains climate. These minimise the stress and strain on the economy of the body. The Sanatorium opens out to a patient an expanse of free space with beautiful sceneries which enhances his well-being. Because of the more bracing climate and

[1] *British Journal of Surgery*, 22. 264-268, 1934. 264-268.

[2] *Indian Medical Gazette*, 69, 554 558, 1934.

[3] *Diseases of the Testicle* By Hamilton Bailey, F.R.C.S. (Eng). (H. K. Lewis & Co. Ltd. London).

Recent Advances in Genito-Urinary Surgery. By Hamilton Bailey, F.R.C.S. (Eng.) and N. M. Matheson, M.B., F.R.C.S. (Eng.) (J. & A. Churchill Ltd., London).

beautiful foot-paths to take graduated walking exercise a patient feels less fatigued than in the ordinary climate.

For the above mentioned reasons a climatic sanatorium is ideal for people who are not suffering from the acute symptoms of the disease *e.g.*, high temperature, frequent haemoptysis, very high pulse rate etc. A patient who can move about without the raising of temperature and pulse benefits most from a sanatorium.

Now a days a sanatorium is usually well-equipped with medical staff and opportunities of modern treatment. The patient gets the benefit of all types of surgical treatment of the disease which, in recent times, has gained a very large ground in the treatment of the disease. The patient derives the advantages of the climate and as also of the more important factor—good medical care. The result, therefore, is an all-round gain for the patient.

We give, herewith, the amenities and results of treatment of one of the climatic sanatoriums of India.

The Annual Report of King Edward VII Sanatorium, Bhowali, U. P. for 1937

The Sanatorium is situated at an altitude of 6,000 ft. above sea level. It is situated in the hills covered with vegetation and away from crowded habitations. Its atmosphere is free from smoke and dust.

The climate is dry and bracing throughout the year. The average annual rainfall is 83 inches. The average mean temperature from March to November is 76°F with a minimum of 50°F and a maximum of 90°F. It is colder from December to February but the climate is invigorating.

In the year under report the Sanatorium has an accommodation for 142 patients. A number of social events and recreative diversions in the way of Tea parties, At Homes, Jugglers shows, Cinema shows etc., are arranged from time to time. The Sanatorium possesses a General Library for books on various subjects in Hindi, Urdu and English, newspapers and periodicals and a medical Library for books and journals on tuberculosis and general medicine.

During the year, 236 patients are admitted into the Sanatorium, 245 treated and 213 discharged. Of these 213, very few cases (10) occur between 5-15 years and the number increased more rapidly after this age period. The incidence again is more rapid and the maximum reaches earlier in the famales than in the males between 5-20 years.

The greatest number of patients occurs among the Hindus, majority of which comes from the Kayastha and Vaishya communities. The incidence is also found to be greatest among the married people. Regarding occupation, the largest number of patients comes from the student class and next in order from the housewives and clerks.

Of the 213 patients discharged from the Sanatorium, 13 stayed there for less than a month and 9 were free from active disease. Of the remaining 191 cases 150 were males and 41 females and the disease was slight in 25, moderately advanced in 38 and far advanced in 128 *i.e.*, in more than half of the patients. Majority of this latter class of patients showed, on admission, a range of temperature from 90°F to 102°F and above. The tubercle bacilli were present in 68.6% patients on admission and remained present in 50.3% at discharge and this is found mostly in the far advanced cases.

As regards the results of treatment, 30.3% of patients were arrested, 12.5% much improved, 27.2% improved, 15 1% stationery, 13.08% worse and 1.5% dead. All with slight disease, 35 out of 38 of moderately advanced cases and 74 out of 128 of far advanced cases were arrested or improved.

Sanatorium routine treatment, Gold therapy, Artificial pneumothorax and Phrenic evulsion are the main methods of treatment adopted in this Sanatorium along with X-Ray work and laboratory examinations of sputum, blood, urine and foeces.

Medical Article for September

The following article on 'The Incurables' has been contributed by Bt.-Col. R. N. Chopra, Director, School of Tropical McMdicine, Calcutta for our 'Medicine and Public Health' section of the present issue of the journal.

The Incurables

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From the earliest days of history, life has imposed its stress and strain upon mankind. The continual strife with the elements, the dreadful toils and dangers a man has to undergo, bring about ill health and disease which may end his uncertain existence. Man is terribly afraid of death, and makes every effort to prolonging life as much as possible. In order to accomplish this, the body should be kept in good working order and if ill health supervenes, it should be combated. Unceasing struggle has therefore been carried on against disease from the earliest days of man's existence. Gods and goddesses were created to protect him from evil, and deities in anger or demons were propitiated by charms and amulets. After centuries of struggle, the spirit of science dawned and with it the will to go into the exact nature of the causation of disease, by experiment and research. Thus a more rational way of fighting disease was evolved. In this struggle, workers in different ages, found that they could combat certain diseases with success, while against others they were powerless. These were termed *incurable diseases*. As science progressed many incurable diseases were conquered; what was regarded as incurable in one age, became amenable to treatment or preventable in another. Great scourges such as plague, cholera, small pox, leprosy, etc., are all in the process of being conquered. Development of preventive methods and advances in treatment, have succeeded in freeing people in the western countries from many of these pests. Unfortunately, because of our imperfect methods of dealing with them in India, they still take a heavy toll of life and leave a trail of woe behind.

Definitions and Types of Incurables

Ordinarily speaking, the term 'incurable' is applied to those unfortunate victims of disease, in whom treatment with all its advances is ineffective and the rate of advent of death cannot be influenced. Such diseases or conditions may be *acute* or *chronic*. An instance of the former is hydrophobia, an acute infective disease produced by a virus which is communicated to man by the bite of a rabid dog, jackal or wolf. When once the disease is established, there is no hope of recovery, but modern research has made its onset preventable by prophylactic treatment. Other diseases in this category are galloping phthisis, acute leukaemias, a number of infectious diseases such as advanced tetanus, pneumonic plague, fulminating meningitis and acute poliomyelities. In the case of this group inspite of all efforts on the part of science the advent of death cannot be prevented, and the sufferer is relieved from his misery in a short time.

In the chronic type of incurable diseases, however, the unfortunate victim may go on suffering and lingering for prolonged periods. There are two main groups in this class. The first in which the disability produced is not marked in the early stages, and the individual afflicted may be able to carry on for many years without being a burden to society. Such conditions are diabetes, kidney and heart disease, epilepsy, early malignant disease, etc. Considerable advance has been made in the treatment of these diseases during recent years and they are rapidly becoming preventable or curable by the development of techniques of early diagnosis. To the second group belong those who are permanently incapacitated from earning their livelihood, and need active care by the community. Advanced phthisis, tubercular disease of bones and joints, blood diseases such as leukaemia, nervous diseases, epilepsy, leprosy and others may be included in this group. Science is making valiant efforts to bring them under control and success has attended in several directions. But cancer is a disease which has baffled medical science, and the problem of causation of this dreadful disease is still unsolved inspite of the enormous amount of scientific research. Not only do we not know what cancer is, we do not even know to what category of diseases it belongs, whether microbic, metabolic or degenerative. It is the stalking spectre among diseases and it is surrounded with all the horror which attaches to the incomprehensible. Medical research has made a large majority of cases of accessible cancer in early

stages, amenable to surgical, röentgenic (chaoul and deep X-ray) and radium treatment so effectively as to render recurrence unlikely. But unfortunately many cases are not seen early enough and in many more the seat of the disease is not accessible and in such cases the end is inevitable. No one who studies the rapid progress which the medical science is making can doubt that even this disease may become preventable or curable. Cancer accounts for a large number of incurables in the West, but fortunately its incidence is lower in this country. Those afflicted with it suffer intolerable pain and anguish, often for prolonged periods, before death relieves them of their misery.

The incurables belonging to the class of imbeciles, idiots, and those suffering from mental disorders, have presented difficulties so far as prevention and cure is concerned, in fact, the last named class has showed a definite increase on account of nervous strain imposed by life in large towns. These are adequately dealt with in most countries in asylums or mental hospitals, and science is evolving new methods of treatment for them. A visit to some of the institutions in this country will show what a large number of unfortunate people come into this category, who have no hope of being ever restored to health and who are a burden to themselves and to society. Then there are the maimed and paralysed individuals who are the victims of congenital defects, nerve diseases, advanced leprosy, lathyrism, street accidents, venereal and rheumatic infections, filariasis, etc. A very large group in this country are those afflicted with blindness, which is so often preventable. These people have generally suffered from diseases that have passed away but have left a terrible legacy behind. In many cases in this group the much needed care by the community is often not forthcoming and the sufferers are left to the mercy of elements. These unfortunate individuals account for the large proportion of the beggar class in large towns in India.

Statistics

This brief review of the incurable diseases, will give one some idea of the importance of this problem and what medical science is doing towards its solution. While in many of the western countries adequate arrangements are provided to ameliorate the lot of these sufferers, in India little attention has been paid to the problem. According to the last census report (1931), there are 120,304 insane, 230,895 deaf-mutes, 601,370 blind and 147,911 lepers in India. A very large number of the population of this country suffer from various debilitating diseases which not only considerably reduce the working capacity of the people, but many are rendered totally incapacitated. The Annual Report of the Hospitals and Dispensaries under the Government of Bengal (1935) shows that there are 100,626 cases suffering from venereal diseases or their sequelæ, 36,281 from tuberculosis of various forms, 6,508 cases of chronic leprosy, 24,810 of malignant tumours, 4,821 of filariasis causing definite disablement, and 4,129 cases of mental diseases, all of the incurable type. If this is the condition of one province in India, the condition of the rest of the country may be easily imagined. Only a small fraction of this large group are looked after. A cursory examination of the beggar class of any of the big cities will convince one of this.

It is to be greatly regretted that no organized effort has been made so far to deal with the important problem of incurables in this country. The public interest should be roused, and something should be done to bring into action the discoveries of medical science towards the prevention of incurability and proper care of the incurables. Illiteracy and ignorance among the masses are responsible for the production of a large section of the incurable class. Intensive educative propaganda is needed. One has only to see what has been accomplished in some of the Western countries, and to know how much can be done not only to diminish the number of incurables, but also to make the life of those who suffer from incurable affections less miserable and more contented. The platform, the stage, films, radio and newspapers combined have changed the whole aspect of the problem in the West. The same can be done in India.

Remedies: Research, Treatment and Establishment of Institutions

The causes leading to the creation of an incurable class should be thoroughly investigated and adequately dealt with. It has been roughly estimated that 30 per cent. of the maimed beggars on the streets of large towns such as Calcutta are drawn from advanced types of leprosy. Adequate treatment in the early stages would almost entirely eliminate this factor. Then there are a fair number of mentally deficient individuals and morons in every community and state, who can be easily

rehabilitated if proper care and attention is bestowed on them. Homes like the "Bodhana Samiti" have already made good progress in this connection. Lathyrism and elephantiasis could be stamped out if suitable preventive measures indicated by medical research are taken. About 10 per cent of the beggars are blind. Blindness may be present from birth but more often it is produced by small-pox, corneal ulceration, venereal diseases and nutritional defects, which are all preventable in the light of modern discoveries. It has been estimated that venereal diseases which are now preventable and curable are responsible for 10 per cent of blindness in children and 60 per cent in adults. The institution of eye clinics and travelling eye dispensaries will do much to reduce this group.

As regards the measures which can be taken to make the lot of incurables happy, much has been accomplished in the West, but even the fringe of the problem has not been touched in India. To start with, no accurate information is available with regard to the number of persons suffering from chronic incurable diseases. With the exception of a few homes for Europeans and Anglo-Indians, there are few dis-jointed organizations which interest themselves in this question. The Ramkrishna Mission Hospital in Benares is one of the few institutions in India where incurables are cared for, but the problem needs much wider attention. Apart from mental asylums there is a genuine need for public institutions for incurables who are unable to look after themselves.

Broadly speaking there are three types of incurable persons:—

(1) Those who require active medical aid in a hospital or infirmary.

(2) Those who need skilled nursing.

(3) Those for whom custodial care by competent attendants is necessary.

Well-organized homes and colonies should be started to deal with all these three groups. Apart from lunatic asylums a few such institutions exist for lepers, but all too inadequate, and none for other groups. The Calcutta Corporation has recently appointed a committee to go into the Beggar Problem which has a bearing on this problem of incurables. It has been estimated that there are more than 12,000 beggars in Calcutta alone. Many of them suffer from incurable disease. A proposal has been put forward to start a more commodious 'refuge' where such people can be looked after. In Bombay, a similar scheme is on foot and all other towns should follow this lead. Such places could contribute substantially to their own upkeep, if the inmates were taught a number of lucrative trades. A few institutions for the blind are already in existence and are doing excellent work. It may be emphasized that the Government and municipalities can help by giving grants to such organizations but they cannot be expected to shoulder the entire burden. The public should realize their responsibilities and come forward with donations as is done in western countries, to help in the solution of the problem of the incurables by promoting medical research and palliative measures. The responsibility of the State and society is at least as great towards this class as towards the acute sufferer from disease.

The migration of beggars to large cities and prosperous places should be prevented and the able-bodied beggars should be made to earn their living. A Vagrancy Act suitable to the conditions in India may be enacted and enforced by the municipalities, district boards, and other such bodies.

The industrial workers and others whose earning capacity is small could easily contribute small amounts commensurate with their means to a central organization, which would take care of them and their families in case of permanent incapacity and disablement. The employers, the State and the public could make contributions. In the present state of medical relief in India, with large numbers of unqualified practitioners of indigenous medicine, the introduction of a Health Insurance Act may present difficulties, but, sooner or later, it bound to come in some modified form and this will greatly help in the solution of this problem. The National Health Insurance Act was put on the Statute Book in England in 1924. All employed persons of either sex, of the age of 16 and upwards and certain voluntary contributors are entitled to the benefits in respect of health insurance and prevention of sickness. The expenses are defrayed by contribution of employees and employers, supplemented by money provided by Parliament. The benefits conferred are medical treatment and attendance, including the provision of proper and sufficient medicines. Sickness and disablement benefits and maternity benefits are also provided. Something of this nature could be started in India.

MEDICINE AND PUBLIC HEALTH

"Euthanasia" or Painless Killing

The problem of hopeless incurables who suffer from intense pain has lately been engaging the attention of people in the West. The Euthanasia Legislation Society in England has sponsored a bill for the solution of this problem which has been hotly debated. It has been proposed to put an end to people suffering from excruciating pain of an intolerable and incurable nature such as of carcinoma in a painless and merciful manner if they so desired. Minors and insane people were excluded from the scope of this Bill. The patient with the consent of his relatives would have to make a request in writing on a prescribed form and to submit two independent medical certificates. The "referee" would satisfy himself about the presence of any abuse. Euthanasia is to be performed by a licensed doctor at a suitable occasion. The Voluntary Euthanasia Bill was introduced into the House of Lords but was not passed. The idea has received support from a section of the clergy but the physicians themselves are divided about its advisability. Some of the noble Lords preferred the continuance of illegal euthanasia to the rigid provisions of the Euthanasia Bill. While admitting the soundness of the principle of euthanasia one cannot help considering its practical effects. Besides the abuses which may follow, the sentiment is that no man has the right to take the life of another whether he be deformed, blind, deaf and dumb or dying. Such practice may be repugnant to many medical men who consider that their duty is only to cure and not to kill. There are many remedies and much more control of pain to-day than formerly, and it is the duty and privilege of the medical man, if he is not able to produce a cure, to do what he can to make the passage between painful illness and the inevitable end as gentle and comforting as possible.

In conclusion, I wish to say a few words about the relationship of medical research to the problem of incurables. The progress made through many decades of laborious research has paved the way for suppression of epidemic diseases such as small-pox, typhus, cholera, plague, enteric, etc., which used to decimate countries and are now paving the way for many others. Research in preventive medicine has brought the principles of prevention into their true perspective. In the light of recent advances the occurrence of such diseases in civilized countries is a matter of great reproach. Medical research has shown the way and exprience has proved the truth of the results that have been obtained.

In an editorial on medical research in India in the August number of the Calcutta Medical Journal, the writer has clearly brought out the lack of public interest in medical research in this country. In countries like Great Britain, large sums are set apart for medical research and investigation on other aspects of medicine than the curative side. This does not signify that curative side is any the less important, but the feeling is gradually gaining ground among the medical scientists in England, Germany, France and America that there are tremendous potentialities in the field of medical research other than curative and that all the available resources should be harnessed to strengthen medical research in its various aspects. In India unfortunately the contribution towards medical research by the State is very small as compared with the size of the country. From the public munificence the contributions are conspicuous by their entire absence. The reason for such neglect is that the true meaning, aim and objects of research are not understood by the public. Because research does not immediately lead to epoch-making discoveries and does not always bring sensational results, the importance and value of medical research and the need for support by private individuals are not sufficiently appreciated. Until this is done, the problem of incurables will remain unsolved in this country.*

* Based on a broadcast talk from the Calcutta Station. Second lecture in "Progress of Science Series" of the All-India Radio.

RESEARCH NOTES

Urinary Cholesterol in Cancer

The structural relation of several potent carcinogenic hydrocarbons to cyclopentenophenanthrene, which forms the cyclic portion of cholesterol, bile acids, and steroid hormones, has given rise in recent years to various speculations concerning the rôle which cholesterol and other steroid derivatives may play in tumor metabolism. Tumour tissue is known to be richer in cholesterol than any parenchymatous organ, exclusive of the brain, so that cholesterol is linked in some peculiar manner with tumor metabolism.

The cholesterol excretion through the kidney is minute under normal conditions, but considerable amounts are found in the urine of nephritic patients and in chylous urine

Bloch and Sobotka (*J. Biol. Chem.* *124*, 567, 1938) examined the urine of hospital patients and found in the urine from cancer patients an average of 400 mg. per 100 liters as against an average of 30 mg. of cholesterol per 100 liters of urine from normal individuals.

The rise of urinary cholesterol to more than 10 times the normal value may not be characteristic for cancer urine but a symptom common to any group of cachectic patients. Therefore, controls were run on urine from cardiac and consumptive patients; these gave figures of 50 and 20 mg. of cholesterol per 100 liters respectively, figures which correspond with the values for normal subjects. The authors attribute the high cholesterol level in cancer urines to the continuous destruction of tumour tissue.

The study of urines collected from individual patients will throw light on the question whether cholesterol urea is an expression of abnormal cholesterol metabolism or merely of increased catabolism of cholesterol-rich tissue.

—*H. N. B.*

Composition of the Milk from the Breasts of Newly-born Infants

It is well known that most infants of both sexes secrete milk when newly-born, the secretion being termed Witches' or Sorcerers' milk. The phenomenon is ascribed to puerperal involution in the mammary glands of the newly-born infants, and the secretion is considered to be imperfect milk loaded with leucocytes, often ending in abscesses.

Five samples of such secretions were collected from infants of both sexes between 9 and 17 days old and submitted to analysis. Davies and Moncrieff (*Biochem. J.* *32*, 1238, 1938) obtained the milk by gentle squeezing of the enlarged breasts, the milk then being sucked up by a pipette and transferred to small glass bottles containing a trace of formalin. The yields were variable but in no case exceeded 1·8 g. Determinations were made of total solids, nitrogen distribution, sugar and chloride content and evidence of the presence of peroxidase and phosphatase. Fat and mineral content could not be deter[illegible] for want of material, but all samples appeared to contain fat since they showed the property of creaming on standing. The highest total solids occurred around the 9th day, protein accounting for most (60-80%) of the solids. It is probable that the secretion is at first watery, rises in total solids and protein content to the 9th day, and then decreases in solids slowly and in protein rapidly, due to resorption in the following days. The secretions bear some resemblance in composition to those from the udders of pregnant

heifers and dry non-pregnant cows and tends to resemble colostrum in composition.

—*H. N. B.*

The Proximate Analysis of the Organic Constituents of Soils

J. M. Shewan (*J. Agri. Sci., 28*, 324-340, 1938), has analysed the organic constituents of several profiles from north-east of Scotland. He has used the system of analysis proposed by S. Waksman and K. Stevens (*Soil Sci., 30,* 97-116, 1930), but has used various modifications in order to obtain greater accuracy. Shewan points out that it is necessary in the ether extraction of the organic matter to digest the soil with ether for 24-30 hrs. instead of 10-16 hrs. as done by Waksman and Stevens. For the determination of cellulose fraction Shewan has used 80% sulphuric acid for 2½ hrs. at 12-14°C (Waksman does not control the temperature). Several other modifications have been recommended with respect to the determination of reducing sugars produced from the hydrolysis of hemicellulose and cellulose. The method which has been finally adopted for the determination of reducing sugars is as follows:—

10·25 c.c. of the acid hydrolysate are neutralized, made alkaline to brom cresol-purple with 2.5% NaOH, allowed to stand for a few hours with frequent shaking, after which the iron-manganese precipitate is filtered and washed and the filtrate made up to 100 c.c. (In some cases two precipitations are necessary). Fehling's solution is added (Lane and Eynon's A and B), the mixture boiled and a standard glucose solution is run in until an end-point is reached, using 3 drops of 1% methylene blue as indicator. The whole operation must be completed 3 minutes after boiling commences. The standard solution is treated in the same manner.

The determination of the organic constituents of soil is very important, but so far no method, including that proposed by Waksman and Stevens, has been found to be satisfactory. The modified procedure proposed by Shewan seems promising and should be tried with different types of soil.

—*S. P. R.*

Lysine Content of Foodstuff

Osborne and Mendel demonstrated conclusively that lysine was an essential amino-acid for normal growth and that the nutritive values of a number of proteins were closely related to their lysine contents. Morris and Wright found that a deficiency of lysine or tryptophane in the rations of milking cows lead to a marked reduction in milk yield. Estimation of lysine by the Van Slyke nitrogen distribution method is very unsatisfactory. The isolation method of Kossel and Kutcher as modified by Vickery and Leavenworth is better but requires large amounts of material. This method, modified by Block (*J. Biol. Chem. 106*, 457) may be applied to small quantities of protein but this method is also unsuitable for impure proteins.

C. A. Ayre (*Biochem. J. 32*, 1152, 1938) has effected further modification in Block's method resulting in gain in time and saving of labour. The method when applied to a food containing a low percentage of lysine (wheat gluten) was not successful due to the very high percentage of proline in the stuff.

—*H. N. B.*

University and Academy News

National Academy of Sciences, India

An ordinary monthly meeting of the National Academy of Sciences, India, was held on April 29, 1938, in the Physics Lecture Theatre, Muir College Buildings, Allahabad, with Prof. D. R. Bhattacharya in the chair.

The following papers were taken as read:—

1. "Studies on the trematode parasites of fishes. A new trematode *Nizamia Hyderabadia* N. Gen., N. Sp. from the intestine of a fresh-water fish, *Ophiocephalus* punctatus," by J. Dayal, Esq., M.Sc., Zoology Department, Lucknow University, Lucknow.

2. "Caustic Soda and Alumina from Salt and Bauxite". (A new process of manufacture), by V. S. Dubey, Y. P. Varshney and R. S. Sharma, Department of Glass Technology, Benares Hindu University, Benares.

3. "Notes on the Microscopic studies of the Igneous Rocks of Elephanta, Trombay and Salsette Islands and the Parnera Hill", by Prof. A. S. Kalapesi and R. N. Sukheswala, St. Xavier's College, Cruickshank Road, Bombay 1.

4-11. "Studies on the effect of alcohol on the metabolism of green leaves", Parts 1 to 8, by Dr U. N. Chatterji, D. Phil., National Academy of Sciences, India, Allahabad. (Communicated by Dr S. Ranjan).

12. "Chemical Examination linifolia Retz." Part 1, by Messrs Mahadeb Prasad Gupta and S. B. Dutt, Chemistry Department, Allahabad University, Allahabad.

Institution of Chemists (India)

The following are the Members of the Council for 1938-40.

President—Mr. N. N. Sen Gupta.

Vice-Presidents—Dr K. N. Bagchi; Dr Gilbert J. Fowler; Dr B. C. Guha; Dr Ali Karim; Dr H. K. Sen; Dr E. Spencer; and Dr T. S. Wheeler.

Hony. Treasurer Mr K. B. Sen.

Hony. Secretaries—Dr N. Ghatak; and Mr S. N. Sinha.

Members Mr Ronald Alcock; Dr C. Barat; Mr J. R. H. Bartlet; Mr N. K. Chatterji; Mr P. K. Das Gupta; Mr B. B. Dhavale; Dr D. R. Dhingra; Mr D. S. Naidu; Mr N. Sen; and Mr H. King.

An ordinary meeting of the Institution of Chemists (India) was held on Thursday, the 14th July, in the Chemical Lecture Theatre, University College of Science, Calcutta, with Mr. N. N. Sen Gupta, M.Sc., A.I.C., the President, in the chair. The following paper was read and discussed:—

"Studies on main principles and electro-chemical observations involved in a dry cell" by Mr P. B. Sarkar, M.Sc.

A visit of the members of the Institution of Chemists (India) to the Factory of Messrs. the Bata Shoe Co., Ltd., at Batanagar, was arranged on Thursday, the 18th August 1938.

Dr Gilbert J. Fowler, delivered a lecture on "Research and Investigation" at an ordinary meeting of the Institution of Chemists (India) on the 21st August, 1938.

UNIVERSITY AND ACADEMY NEWS

Calcutta Medical Club

The following clinical meetings were held under the auspices of the Club during August 1938.

Friday, August, 12, 1938, at 7-30 p.m.

Subject: Intestinal amebiasis: its clinical manifestations.

Speaker: Dr Probodh Kumar Banerjee, M.B.

Friday, August 19, 1938, at 7-30 p.m.

Subject: Fracture spine and its treatment.

Speaker: Dr Provat Chandra Sanyal, M.B. (Cal.) F.R.C.S. (Eng.).

Friday, August 26, 1938, at 7-30 p.m.

Subject: Mental diseases in general practice.

Speaker: Dr Sudhindra Nath Banerjee, B.Sc., M.B. (Cal.) D.P.H. (Lond.).

The National Institute of Sciences, India:

The Ninth Ordinary General Meeting of the National Institute of Sciences of India, was held on Saturday, the 20th August, 1938 at the Royal Asiatic Socity of Bengal, Calcutta.

The following papers were read and discussed:

1. Notes on Vredenburgite (with Devadite), and on Sitaparite by Sir L. L. Fermor.

2. The Role of Nitrogen compounds in the fermentation of Fruit Juices by N. N. Chopra.

3. Bio-chemical Investigation of the Tuberculation of Water Pipes by S. C. Pillai.

4. On the Ionisation of the Upper Atmosphere by M. N. Saha and R. N. Rai.

5. Levi-Civita's formulae for two bodies by Sir S. M. Sulaiman.

At the Council Meeting held on the 19th August, the following were nominated to be Honorary Fellows of the Institute.

1. Sir Arthur Eddington, D.Sc., LL.D., F.R.S., Plumian Professor of Astronomy and Experimental Philosophy, Cambridge University.

A life-sketch of Sir Arthur Eddington was published in SCIENCE AND CULTURE, January, 1938. Recently he was been decorated with an Order of Merit.

2. Prof. R. A. Fisher, Sc.D., F.R.S., Galton Professor in the University of London.

Prof. Fisher was awarded the Weldon Medal of the Royal Society in 1929. Apart for his great distinction as a scientist, his influence has been the most powerful in recent developments in connection with agricultural field trials in India. In fact the Fisherian technique has led to a great progress in Indian agriculture.

3. Prof. J. Perrin, Sorbonne, Paris.

Prof. Perrin is one of the most eminent French scientists, wellknown for his work on the sign of the charge of the electron, (1895) and on Brownian movement on which a Nobel prize was awarded.

4. Sir John Russell, D.Sc., F.R.S., Director, Rothamsted Agricultural Experimental Station, Harpenden, Herts., England.

Sir John Russell is an eminent scientist and the leading soil scientist in the United Kingdom. He visited India for about six months in 1936-37 at the request of the Imperial Council of Agricultural Research and furnished a most valuable report on the future development of Agricultural Research in India.

Book Review

Hints on Museum Education, *by J. C. Basak, pp. 1-282 (1938).*

It is very difficult to review a work which deals with subjects quite alien to what one would expect from its title; such unfortunately is the case with the work under review. From the title " Hints on Museum Education " one would expect a guide for museum authorities, such as museum curators and others responsible for the management of museums, regarding the methods to be adopted for making museums serve for the advancement of knowledge, but this is exactly what is wanting. In an introductory chapter the author deals with the importance of educational museums, but his method of treatment is very subjective, and so many subjects are mixed up in the short compass of 14 pages that the main issue becomes almost shrouded in details that have little to do with museum education. In a second chapter under the heading " Preliminary Remarks " are discussed such diverse subjects as the Spread of Museum Knowledge, Useful *versus* Ornamental Knowledge, Well-directed Education, Memory not to be taxed Improperly, Instances of Useful Knowledge, Study of Arts and Sciences and Exhibits of the Three Kingdoms, General Knowledge of Technical Subjects with sub-headings ' Botany ' and ' Zoology ', Mental Hygiene and Child Psychology, Curious or Wrong Notions about Educational Museums, Mass Education in the Indian States, Children's Museums, and Properties of Objects as perceived by the Five Sense Organs. The variety of subjects treated in this chapter makes one wonder what the author's conception of the functions of a museum is. No one denies the great service rendered to education by educational museums and exhibitions of industrial objects in science museums, but the author devotes a page or so to museum work and several pages to defective curricula of educational institutions, instances of useful *versus* useless knowledge, the importance of the study of arts and sciences, etc. In fact the work appears to be based on such an imperfect acquaintance with the work of museums either in Europe and America or even in India that it is very doubtful whether his analysis would serve any useful purpose. The major part of the book (pp. 57-270) is devoted to classification of exhibits under headings like Foods, Ordinary Drugs, Medical Appliances, Houses and Architecture, Stamps and Coins, Mechanics and Machines, Arts and Manufactures, Physics, Electricity, Some Mysterious Sciences, School Exhibits, Pictures, Nativities, Horoscopes, Useful and Interesting Information, Museum Library, Children's Museums, etc., arranged in 34 chapters. These accounts are useful compendia of a heterogeneous mass of information on very varied subjects, but their utility for museum education is very doubtful. As an instance may be noted the fact that whereas some 98 pages are devoted to a description of the properties of ordinary foods and drugs, less than half a page deals with objects that should be exhibited in the Food section, and not a word about Drug exhibits. In a final chapter under the heading " Suggestions for Reformation " the author discusses certain recommendations of the representatives of the Museums Association as laid down in their report on the " Museums of India " and offers suggestions for the improvement of the Indian museums. One of these is to transform the National museum of India, the Indian Museum, Calcutta, into what he considers to be an urgent need of the country, *viz.*, a science museum, a technical museum, a public health museum, a children's museum and everything else in museum line all combined into one; such an octopus, the exact funtions of which the author has not set forth, has not been possible either in Europe or America,

and one cannot understand how such an institution could ever be established in India with the very meagre funds that are available for museums in this country. Even if established, the incubus of such a gigantic institution is sure to stultify the main purposes which it is expected to serve.

—*B. P.*

INDUSTRIAL AND NEWS EDITION OF THE JOURNAL OF THE INDIAN CHEMICAL SOCIETY, *Super Royal 8vo. pp. 82, price Rs 3/- for single issue.*

The present issue constitutes the joint first and second numbers of the quarterly publications under the joint auspices of the Indian Chemical Society and the Institution of Chemists (India).

It contains original papers on (1) Bleaching of lac—from Indian Lac Research Institute, Ranchi; (2) Commercial possibilities of a new detergent—from Indian Forest Research Institute, Dehra Dun; (3) A short note on photo-electric colorimeter for the estimation of absorption of dye—from the Technological Laboratory of the Indian Central Cotton Committee, Bombay; (4) The distinction between oxy-cellulose and hydrocellulose—from the Laboratory of Chemical Technology of Bombay University; (5) Indian Coals for the manufacture of white Portland cement—from the same laboratory; (6) Studies on Indian Coals, Proximate composition and low temperature carbonisation—from the Technological Laboratory of the University College of Science, Calcutta; (7) By-products of Citrus fruits—from Government Industrial Laboratory, Lahore. In addition to the seven original contributions, the issue contains thoughtful articles on "Mineral element in Nutrition" by Dr U. P. Basu of Bengal Immunity and "Chemistry and Development of Industries in India" by Dr K. G. Naik, Government Industrial Chemist, Baroda. The inclusion of industrial research notes collected from foreign periodicals, notes of scientific interest and extracts from the Indian patent literature has made the publication useful and attractive.

A publication of this type will disseminate industrial and scientific news, and bring about contact among the chemists and the industrialists and will thus go a great way in promoting chemical industries in India. It has thus removed a long-felt want.

The organisers of this publication are to be congratulated for this excellent specimen of the first number. The get up and printing of the journal leaves nothing to be desired. It has been offered to the Fellows and Subscribers of the Journal of the Indian Chemical Society at a concession rate of Re 1/- and Rs 2/- respectively.

—*G. B.*

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the letters.]

Effect of Light Rays on the Physical Properties of Protein Solutions

Proteins, as a rule, are changed by the action of light. The main function of the light is not only to bring about a physical change in it but also to affect therapeutic properties of the protein solutions. In order to study the reasons of gel-formation and gradual deterioration of anti-toxic serum in light, different protein solutions were exposed to diffused light, open sun-light and ultra-violet light respectively.

We have noticed that in sera (anti-toxic, anti-bacterial or normal horse serum) there is a gradual change in colour, relative viscosity and *p*H. But no such change was observed in toxiod solutions. In the diffused light changes take place very slowly, and the exposed sun-light of June (containing maximum ultraviolet rays), the rate is a bit rapid, but the sharpest changes were noticed in unfiltered ultraviolet rays from a mercury lamp. This gradual change of *p*H towards acid region is observed in all the sera but not in toxiod. The diffused and open sun-light favours the formation of sediments in sera, while ultra-violet rays cause gel-formation due to the greater intensity of the actinic rays. It is noteworthy that, though the total protein before and after the exposure to light remains the same, still the amount of total globulin in the sera gradually increases at the cost of albumin portion of the sera, so that the behaviour of sera, towards ammonium sulphate is erratic. The results of a typical experiment are given below:

Original Serum	Irradiated Serum (1 hr.)	Sun-light exposed Serum. (8 hr.)
Globulin—10.37%	11.1%	10.7%
Albumin—3.8%	3.1%	3.5%

It is interesting also that the fall of titre per c.c. was abrupt in anti-toxic and anti-bacterial sera, but in case of toxiod no change in flocculative unit was observed. Further work is in progress and the paper will be communicated in due course.

Bengal Immunity Laboratory,
Calcutta.

N. K. Roy Chowdhury.

Floods and Prediction of Flood Levels by River Models

Now that we hear and read in newspapers every day tales of devastating floods in different parts of the country it may be of more than scientific to know that it is possible to predict with a fair degree of accuracy the highest water levels that a river in spate can reach. It will at once be apparent that even if this much of knowledge could be had about the seemingly erratic behaviour of alluvial rivers in flood it will be a great gain. If it is possible to say to what level water in a river will rise when a certain flood will pass a certain point of the river, people in the neighbourhood might be given notice in time and much loss of life and property may be avoided. Apart from this if it is also possible to train a river in such a way from experience gathered from model experiments that the highest flood levels may be reduced by a couple of feet or more, it will mean, as every body who is engaged in flood relief work knows, life or death to thousands of people. It is desired here to describe some experiments that have been recently carried out by the author in connection with Emerson Barrage Project of the Punjab Irrigation.

When it was decided to build a barrage across the river Chenab to divert from its main course the waters of both the rivers Jhelum and Chenab over a weir it was feared that the river levels upstream of the bund will go up and consequently innundate the villages in the Khadir of the rivers. Accordingly protective bunds had to be raised for miles and miles upstream of the weir on both sides of the rivers. It was desired to know to what minimum heights these bunds should be raised so that the river may not spill over even in the highest flood that has ever occurred in this river. This information was urgently required as it not only meant the saving of lives of thousands of men and of property but it gave valuable information during the period of construction. As the period of construction generally takes two to three years and the weir is built across one of the arms of the river through which water flows in summer months a ring-bund is generally put round the area in which the work of construction goes on. It is very important to know to what minimum height this ring bund should be put up so that the river may not spill over into the area enclosed by the bund.

To gain these points of information and also those about the shape and position of the guide banks, leading cuts

upstream and downstream of the weir, a model of the river was made. Details of this model are given in a publication of the Punjab Irrigation Research Institute. Here I shall not refer to all the important information obtained from this model but only mention those results that are of immediate interest to us.

A model of the river for a stretch of 6 to 7 miles was built in June 1937 to suitable scales—this included about 3 to 4 miles of the river upstream of the weir site and 3 miles downstream of the same point. A series of preliminary experiments were necessary to fix the scales of the model so that the model could be made to reproduce the conditions of the prototype. After it was proved that the model could reproduce the known conditions of the river it was used to predict conditions that were likely to occur in future. For this purpose the river in the model was surrounded by a ring-bund and discharge for the worst known year (1929) for this river was run month by month. This reproduced the conditions of the river that were likely to occur in 1938, if 1929 floods repeated themselves. River levels were continuously recorded at many important points in the river.

Since the above experiment was completed construction of the Emerson Barrage has started. The river had been bunded by a ring-bund and forced to flow through its right hand channel only. During this period the following gauges had been observed at the Trimmu Boat Bridge Gauge Site. The following table gives the discharges and gauges in the prototype and in the model.

Comparision of Trimmu Gauges for the Floods of 1938 and the Corresponding Discharges in the Model for the Prediversion Runs.

Trimmu Gauge.

Date.	Discharge.	Prototype.	Model.
8-7-38	85,588 cu/sec	486·2 R.L.	485·6 R.L.
28-6-38	133,433 ,,	487·19 ,,	487·0 ,,
18-5-38	150,665 ,,	488·7 ,,	488·0 ,,
17-6-38	105,917 ,,	487·4 ,,	487·5 ,,
13-6-38	187,809 ,,	488·4 ,,	488·3 ,,
26-7-38	300,000 ,,	489·5 ,,	489·7 ,,

Irrigation Research Laboratory, Lahore. N. K. Bose
20-8-1938.

Theoretical Interpretation of the Variation of Electrical Constants of Soil with Moisture Content, Temperature and Frequency

It has been found by various investigators 1,2,3,4 that the dielectric constant and conductivity of the soil vary with the moisture content, the frequency of the impressed waves and the temperature. The nature of the variation of the above constants with frequency has been explained by White[5] by applying Debye's dipole theory but little has been said about the mode of the variation with moisture content and temperature. In this note the variation of the constants with moisture content, temperature and also frequency has been explained by applying the theory of Wagner[6] which is a modification of Maxwell's theory. Wagner-Maxwell model when the conducting particles are spheres sparsely distributed throughout a material of low dielectric loss has been applied in the case of moist soil. The variations of the above constants have been found out experimentally also, and it has been observed that the nature of variation agrees fairly closely with that obtained by this theory.

The generalized dielectric constant for a conducting dielectric is given by the wellknown equation with the usual notations

$$k = k' - i\,k'' \quad . \quad . \quad . \quad . \quad (1)$$

and the equivalent a.c. conductivity is given by

$$\sigma = \frac{wk''}{4\Pi} \quad . \quad . \quad . \quad . \quad (2)$$

It has been shown by Wagner that the real component of the dielectric constant can be given by

$$k' = k_\infty \left(1 + \frac{h}{1+W^2T^2}\right) . \qquad (3)$$

and the imaginary component is given by

$$k'' = k_\infty \frac{hWT}{1+W^2T^2} \qquad (4)$$

where $\quad k_\infty = K_1 \left[1 + \frac{3r(k_2-k_1)}{2k_1+k_2}\right]$

$$h = \frac{9rk_1}{2k_1+k_2}$$

and $\quad T = \frac{2k_1+k_2}{4\Pi c}$

where K^1 and K^2 are the dielectric constants of the dry soil and water respectively,

c the d.c. conductivity of the medium in e.s.u.,
r the moisture content by volume,
h the absorption constant, and
T the relaxation time of the moist soil.

Substituting the values of K″ in equation (2) we obtain

$$\sigma = \frac{W^2T}{1+W^2T^2} \; \frac{k_\infty h}{4\Pi}$$

and substituting the values of K_∞ and h in the above equation we get

$$\sigma = \frac{9k_1^2}{4\Pi(2k_1+k_2)^2} \; \frac{W^2T}{1+W^2T^2} \left\{ (2k_1+k_2)r + (k_2-k_1)3r^2 \right\} \quad . \quad . \quad . \quad . \quad (5)$$

Similarly by substituting the values of K_∞, h, in the equation (3) we get

$$K^1 = K_1 + \left\{ \frac{3k_1+(k_2-k_1)}{2k_1+k_2} + \frac{9k_1^2}{(2k_1+k_2)(1+W^2T^2)} \right\} r \left\{ \frac{27k_1^2(k_2-k_1)}{(2k_1+k_2)_2(1+W^2T^2)} \right\} \quad . \quad . \quad . \quad (6)$$

Equations (5) and (6) show the nature of the variations of the conductivity and the dielectric constant respectively with the moisture content, relaxation time, and frequency.

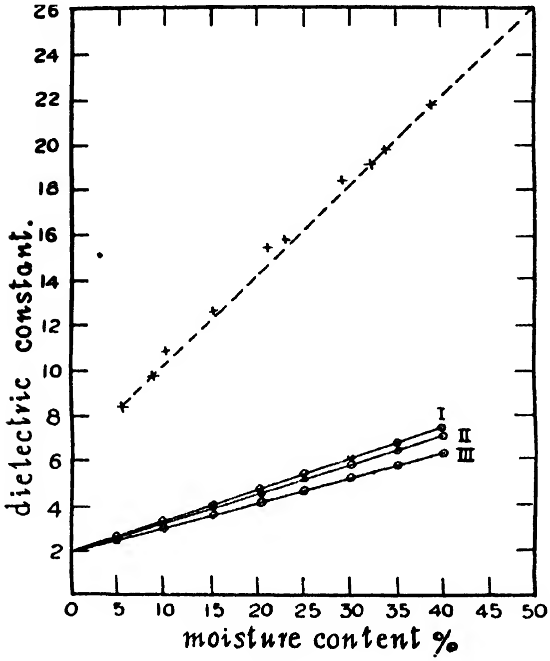

Fig. I

The curves in figs. 1 and 2 show the variation of the above constants as obtained experimentally and also by the above theory. For the sake of convenience three cases have been considered, *viz.*, $w = \infty 0$, $w = \frac{1}{T}$, $w = \infty$. The continuous curves in fig. 1 have been drawn from equation (6) by substituting arbitrary values of the constants K_1, K_2 and T (*viz.*, $K^1 = 2$, $K^2 = 80$ and $T = 10^{-7}$ Sec.) The curves I, II and III represent the values at the above values of w respectively. In fig. 2 curves I and II represent the values of conductivity calculated from equation (5) by substituting the above constants at $w = \infty$ and $w = \frac{1}{T}$ respectively. The value of the conductivity at $W = 0$ will vanish. The dotted curves in figs. 1 and 2 have been drawn from the experimental values obtained at a frequency of 1000 Kc/Sec. (which is nearly the frequency as that of $w = \frac{1}{T}$) by the resonance method previously used by the author[4]. It can be seen that the nature of the variations of the constants with the moisture content is the same as those obtained from the theory. If the constants involved in the two equations be evaluated the theoretical curves will agree more closely with the experimental ones. It will be observed from the continuous curves that the change of conductivity and dielectric constant due to frequency is more pronounced at higher percentage of moisture than at lower one which has been also practically observed by Smith Rose.[1]

The nature of the variation of the electric constants of soil with temperature can also be explained from equations (5) and (6) as the relaxation time involved in the equations will vary with temperature as has been shown by Whitehead.[7]

As regards the change of the constants with frequency according to this theory it is found that the variation is of the same form as obtained by White[5] and the variation with temperature resembles the form obtained by the author shown in a previous communication.[4]

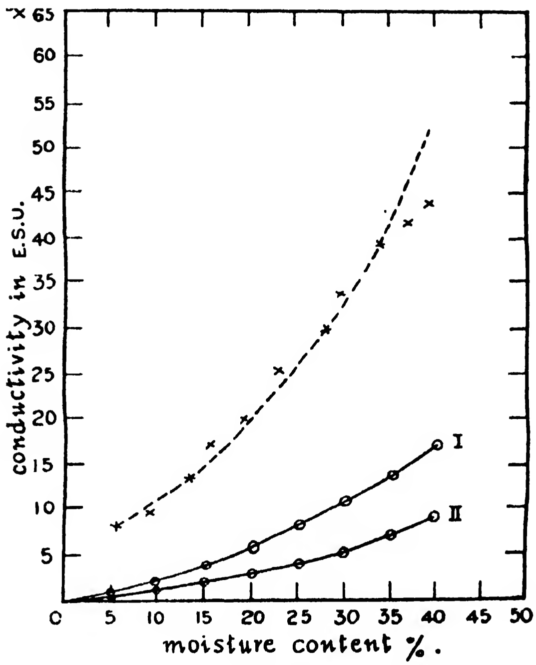

Fig. II

The author has great pleasure in thanking Prof. P. Dutt, M.A., (Cantab) and Dr S. S. Banerjee for their kind interest and suggestions during the progress of the work.

Physics Department, Benares Hindu University
R. D. Joshi.
22-7-1938.

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LETTERS TO THE EDITOR

Destruction of the Neurotoxin of Cobra (Naja Naja) and Dabola (*Vipera Russelli*) Venom by various Reducing Agents

The action of solutions of cysteine and sodium bisulphite on the neurotoxin of Naja flava venom has been recently investigated by Micheel and co-workers[1]. They have found that sodium bisulphite destroys the toxicity of venom.

Recently Micheel and co-workers have observed that sodium bisulphite destroys the neurotoxin present in the crude as well as in the purified venom in a few hours. They have also found that cysteine even in large excess can destroy only 25% of the neurotoxin present in the purified venom. The neurotoxin in the crude venom is not appreciably affected by cysteine. Slotta and co-workers[2] (1938) have tried the effect of cysteine, sodium bisulphite on the venoms of crotalus-t-terrificus and Bothrops jararuca and have noticed very marked destruction of their toxicity by these reagents. Micheel *et al* assumes that a thiolactone ring is present in the neurotoxin and sodium bisulphite causes in activation by breaking down the thiolactone ring. Slotta and co-workers on the other hand think that the neurotoxin contains cystine in its molecule and inactivation is caused by the sodium bisulphite by attacking the S-S linkage and breaking it into a thiol and thio-sulphonic acid. We would like to point out in this connection that the action of sodium bisulphite can also be explained by assuming that it forms an additive compound with the aldehyde or ketonic groups which might be present in the neurotoxin investigated. The effect of a number of reducing agents on the venoms of cobra and Russell's viper was tried and the results are recorded in table I.

It may be noticed from the data recorded in table I that the neurotoxin of Russell's viper venom is far more susceptible than the neurotoxin of cobra venom to the action of all the reducing agents used. If may be mentioned that control experiments with solutions of cobra or Russell's viper venom showed no appreciable loss in activity. The sodium bisulphite when added in small quantities to the solution of Russell's viper venom was found to attack and destroy the neurotoxin first. This suggests a method of obtaining the blood coagulating principle in a condition free from the neurotoxin. Further work is in progress.

TABLE I

Reagents used.	Destruction of the neurotoxin of cobra venom. Crude.	Purified.	Destruction of the neurotoxin of Russell's viper venom.
Sodium Bisulphite:			
1. 2 times the wt. of venom *p*H 5·3	80% in 5 hrs.	....	94% in 5 hrs.
2. 20 times the wt. of venom *p*H 5·0	....	85% in 5 hrs.	....
Cysteine:			
1. 20 times the wt. of venom *p*H 7·6	7% in 24 hrs.		68% in 5 hrs.
2. 200 times the wt. of venom *p*H 7·6		30%	
Ascorbic Acid:			
1. 20 times the wt. of venom *p*H 7·6	*Nil*		72% in 5 hrs.
2. 200 times the wt. of venom *p*H 7·6		30% in 24 hrs.	
Sulphuretted Hydrogen:			
Passed for 15 mins.	*Nil*	*Nil*	85% in 15 min.
Sodium Sulphite:			
2 times *p*H 8·0	10% in 24 hrs	....	77% in 5 hrs.
Hydrochloride Acid & Zn:	38% in 24 hrs.	40% in 24 hrs.	....

Applied Chemistry Department,
University College of
Science & Technology,
Calcutta.
20-8-38

B. N. Ghosh,
S. S. De,
D. N. Chowdhury.

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SUPPLEMENT

Indian Science News Association

Third Annual Meeting

The third annual general meeting of the Indian Science News Association was held at the University College of Science, Calcutta on the 21st August, 1938, at 4-45 P.M. On the proposal of Prof. S. P. Agharkar, Sj. Subhas Chandra Bose, President of the Indian National Congress, was voted to the chair.

The Secretary of the Association, Professor S. K. Mitra, in submitting the report for the period July, '37 to June, '38 reminded the audience that the Association started the journal *Science and Culture* more than three years ago with a view to awakening the interest of the public in the methods of application of science to national regeneration. During the year under review, a few of the subjects discussed editorially and in articles written by specialists were Cheap Electricity, River Problems, Industrial Organisation, Scientific Research Boards, Vernalisation, A new method of Agriculture discovered in Russia—which allows large tracts of hitherto uncultivated regions in Russia to grow food crops etc. It was a matter of regret that the section 'Science in Industry' in which were published articles on new methods of manufacture and new avenues of profit by way of application of the latest discoveries of science, from persons in Technological Institutions and Research Institutes, had not been able to create a lively and also profitable interest among the Industries of the country due to their all-absorbing concern for the economic issues. The high standard which the journal has reached is evident from the fact, that many scientists of international standing responded to our invitation to write for our journal. Such were Sir James H. Jeans, Sir Arthur Eddington, Dr F. W. Aston, Prof. F. K. Morris, Prof. H. J. Fleure etc. The Association received recurring grants from the Universities of Calcutta and Delhi, Indian Science Congress Association, Indian Association for the Cultivation of Science and Bengal Chemical & Pharmaceutical Works Ltd. It also received donations from private individuals and bodies like the Hon'ble Mr N. R. Sarker and the Burmah Oil Co., Ltd.

At the election of the Office-bearers and the members of the Council for the year 1938-1939 (July-June) the following gentlemen were unanimously voted to the Council:—

President:—Dr S. C. Law.

Vice-Presidents:—Sir U. N. Brahmachari; Dr Baini Prasad; Prof. M. N. Saha; Mr S. P. Mookerjee and Bt.-Col. R. N. Chopra.

Treasurer:—Prof. P. C. Mitter.

Secretaries:—Prof. S. K. Mitra and Prof. P. N. Ghosh.

Members:—Prof. P. R. Ray; Mr A. K. Chanda; Mr N. C. Ray; Mr H. P. Bhaumik; Lt.-Col. A. C. Chatterji; Dr N. R. Dhar; Dr P. K. Ghosh; Dr M. Qudrat-i-Khuda; Dr B. S. Guha; Prof. N. R. Sen; Prof. J. N. Mukherjee; Prof. S. C. Mitra; Prof. S. P. Agharkar; Prof. B. B. Ray; Prof. H. K. Mookerjee; Prof. N. C. Nag; Mr B. N. Maitra; Dr D. S. Kothari; Prof. S. S. Bhatnagar and Prof. J. C. Ghosh.

The Board of Editors for the journal during the current year has been constituted with Profs. M. N. Saha, J. C. Ghosh, Dr A. C. Ukil and the two Secretaries.

A scheme for having a board of editorial co-operators was discussed, and adopted.

Prof. Meghnad Saha, in explaining the aims and objects of the Indian Science News Association, said that they were trying to bring to the notice of the public, in simple language, and by means of editorials in their journal, *Science and Culture*, the value of science to the country. The characteristic feature of this Journal is that we always try to present accurate and well-authenticated figures, which tend to create a realistic picture of the situation. This Journal was the first to point out that the production of work per capita in this country is nearly 20 times less than in European countries. Can any other argument point out more forcibly that the

present rate of work output must be multiplied ten times at least if we wish to have any decent standard of living for our masses. This Journal was the first to point out that the output of electricity is only 7 units per capita, and nearly 100 times less than in European countries. Can any other figure be more convincing that the development of natural resources in power has been extremely meagre? We pointed out that the number of museums in this country is nearly thousand times less than in a country like Sweden. Can any other argument be more convincing about the low standard of cultural level amongst the masses of this country?

Prof. Saha quoted an article contributed to *Science and Culture* by Mr Bose written in 1935 from Karlsbad in which he asked scientists and scientific investigators to come to the rescue of political workers in solving the various national problems. Prof. Saha said that the first problem raised by Mr Bose was whether Indian civilization was in the evening of its life or was it on the threshold of a new dawn. He did not want a sentimental but a scientific reply as to whether the awakening that was now witnessed was an organic growth from within, a new creation, or was it a mere response to the impact of the West, of the same character as the reflex of a muscle under stimulus. The second question of Mr Bose, said Prof. Saha, was what were the conditions essential for revivifying a civilization like the Indian that had begun to stagnate. The third question was whether for increasing the vitality of the Indian nation should they promote inter-caste or intra-caste marriages, or whether exogamic marriages were more conducive to the welfare of a people or endogamic.

Till quite recently, wrote Mr Bose in his article, scientific men would have been inclined to say unhesitatingly that India would do well to remove artificial restrictions on marriage. But the new racial theory of the Nazis had made them all ponder over the problem once again. If the Nazi theory was scientifically wrong and if exogamic marriages were really good for the race then Mr Bose thought that it was high time to give a scientific reply to the claims of the Nazi race-theorist.

Prof. Saha also referred to other questions relating to common script, common diet and common dress which Mr Bose raised in his article.

Although the article, said Prof. Saha, was contributed by Mr Bose as early as 1935, most of his questions still remained unanswered and he would try as briefly as he could to reply a few of them.

"To the question whether Indian civilization was in the evening of its life or was it on the threshold of a new dawn my answer," said Prof. Saha "is that if we accept the theory of Flinders Petrie or Spengler there is periodicity of 1500 years in a nation's life. Our lowest level was reached about 1200 A.D. and now we are probably recovering from a long winter of decadence to a spring of new life."

"But" said Prof. Saha "the movements of new life must be properly guided, what is wanted is a new philosophy of life which will renew the springs of our civilization and culture."

This, Prof. Saha believed, would contain the answer to the second question of Mr. Bose.

To his third question about the artificial restrictions on marriage in India, Prof. Saha first referred to the Nazi race-theory.

He observed, "The idea of national and racial superiority is no new phenomenon. Every nation, when it achieves greatness, looks down upon others less fortunate, and tries to find out a cause for its greatness. When Greece became great in the third century B.C., Aristotle, egovistically asked himself: Why the Hellenic nation is the greatest people in the world and proceeded to find out an answer. The cause according to him was meteorological; the northern barbarians (he meant the ancestors of the West European nations) live in such a cold climate that all their energy is spent in fighting Nature. The southerners (Arabs, Jews, etc) live in such hot countries, that they have no energy left to turn to higher things. Greece, he said, has the ideal climate, and the ideal people. Hence, he concluded, Greeks would continue to be the greatest people in the world."

But historical events entirely falsified Aristotle's predictions. Greece practically contributed nothing to civilisation since the 5th century A.D., while the despised barbarians, to whom Aristotle referred in such contemptuous terms, became creators of great civilisations shortly afterwards. In the sixth century A.D., the Arabs created a civilisation of unique type which flourished in full vigour till about the fourteenth. Contribution of Islam to Science and Literature has been simply marvellous. The Northern barbarians of Aristotle created the great West-European civilisation which dominates modern times. The meteorological theory of Aristotle, therefore, completely failed.

The Nazi race theory about the purity of the Aryan race looked, he observed, very much like the theory of *Varnasram Dharma* in this country, which

crystallized into shape about the 2nd century A.D. (time of Manusmriti), when some classes were segregated from others partly on the basis of racial superiority, partly on the basis of supposed superiority of certain profession to others. The result of this theory was the race which peopled India about 1200 A.D. who went down so ignominiously before the Turkish invaders; the theory, which still persists, and has unfortunately set India on its long winter of decadence.

Physical measurements of the Negroes and their brain power showed that they were in no way inferior to the white men and who could foretell that the Negroes of Africa would not be the pioneers of a new and vigorous civilization a few hundred years hence.

Question About Future

"May I put some questions to Mr Bose?" said Prof. Saha in conclusion. "May I enquire whether the India of future is going to revive the philosophy of village life, of bullock cart, thereby perpetuating servitude, or is she going to be a modern industrialized nation which having developed all her natural resources will solve the problem of poverty, ignorance and defence and will take an honoured place in the comity of nations and begin a new cycle in civilization?"

"If the Congress High Command," said he further "decides on a policy of industrilisation, are they going to set up a rationalized scheme of industrialisation and establish a National Researcl Council and mobilize the scientific intelligentsia of the country? I put the question because the Congress has come into power in several provinces and because there is a great confusion of ideas regarding the future industrialisation of India."

"Is India," said Prof. Saha, "going to be one nation or going to be divided into a patchwork of ill-defined provinces and states and communities separated by a babel of tongues and sentiments and artificial political restrictions? We find indications of this in every province of India to-day."

The address of the Congress President is printed separately (Vide pp. 139-141).

Mr G. S. Dutt, I.C.S. in proposing a hearty vote of thanks to the president recalled the other occasions when he came in touch with the Congress President in his official capacity. But at the present moment he stood there as an Indian to offer him homage, who, still young in years, had made his life so noble. He urged for reviving our ancient heritage and culture and opined that in consonance with popularization of science, which the Association is doing through the journal, a synthesis between Science, Culture and Politics should be devised.

At the close of the meeting the guests were treated to tea and light refreshments.

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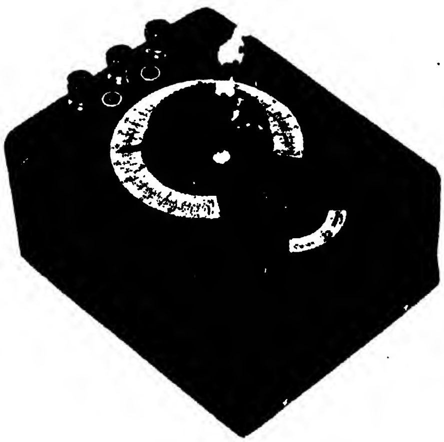

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